Printed on Thin Paper for Foreign Circulation.
"THE ENGINEER," APRIL 29, 1932.

With METALLURGICAL SUPPLEMENT.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLIII.—No. 3981] LONDON: FRIDAY EVENING, APRIL 29, 1932 [PRICE WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

HEATING, &c.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 24th May, 1932, for ADAPTATION of STEAM BOILERS for HOT WATER HEATING, ALTERATION of MAINS and ADDITIONS to HEATING INSTALLATION at the Money Order Office, Holloway, N.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities, and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 8462

London County Council.

ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

APPLICATIONS are INVITED for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advanced study or research in Applied Science and Technology, and will be tenable in the Dominions, the United States or other foreign countries.

Candidates must be British subjects and at least 21 years of age. Further particulars and application forms may be obtained from the EDUCATION OFFICER (T. 3), The County Hall, S.E. 1 (stamped, addressed foolscap envelope necessary), to whom the form must be returned by 1st June, 1932. 8451

Borough of Chepping Wycombe

WATERWORKS PUMPING PLANT.

The Corporation of the above borough invite TENDERS from experienced British Pumping Machinery Manufacturers for the SUPPLY, ERECTION, and SETTING to WORK of ELECTRICALLY DRIVEN PUMPING PLANT, comprising Centrifugal Bore-hole and Surface Pumps having a capacity of 2500 gallons per minute, complete with Pipe Connection, &c., at the Pann Mill Waterworks, High Wycombe.

Copies of the specification, particulars and drawing may be obtained from Mr. W. Vaux Graham, M. Inst. C.E., M. Inst. M.E., 5, Queen Anne's-gate, Westminster, S.W. 1, upon depositing the sum of Five Pounds, which will be returned on receipt of a bona fide Tender.

The work is to be carried out in strict accordance with the conditions laid down for materials and labour by the Unemployment Grants Committee, and the contractor will be required to undertake to commence the work immediately on the acceptance of his Tender.

Sealed Tenders, endorsed "Tenders for Pumping Machinery," must reach Mr. Sydney Young, Waterworks Engineer and Manager, 71, Easton-street, High Wycombe, not later than first post on Monday, the 23rd prox.

The Corporation does not bind itself to accept the lowest or any Tender.

PHILIP B. BEECROFT,
Town Clerk.

High Wycombe,
22nd April, 1932. 8449

Borough of Gosport.

NEW STEEL PONTOON FOR LANDING STAGE.

The Gosport Corporation are prepared to receive TENDERS for a NEW STEEL PONTOON for the Gosport Landing Stage and works contingent thereon.

The contract drawings and specification may be seen at the offices of the Engineers, Sir John Wolfe Barry and Partners, Dartmouth House, 2, Queen Anne's-gate, Westminster, S.W. 1, on and after Wednesday, 27th April, between the hours of Eleven and Four, and copies of the drawings and specification, together with a form of Tender, may be obtained there upon payment of Five Guineas. This sum will be repaid by the Corporation under receipt of a bona fide Tender, accompanied by the specification and drawings, which are to be returned with the Tender.

Tenders, endorsed "Tender for New Steel Pontoon or Gosport Landing Stage," must be delivered under seal at the office of the Town Clerk, Gosport, Hants, on or before Noon on Monday, 16th May.

The lowest Tender will not necessarily be accepted.

R. E. MANGNALL,
Town Clerk.

Town Hall, Gosport,
23rd April, 1932. 8448

City of Manchester.

RIVERS DEPARTMENT.
SLUDGE STEAMSHIP

The Rivers Committee invite TENDERS for the CONSTRUCTION of a TWIN-SCREW STEAMSHIP for the Conveyance and Discharge of Sewage Sludge.

The steamship is required to be constructed by British labour from British material, and is to be built in the British Isles.

Form of Tender, together with general conditions, specification, and preliminary drawings, may be obtained on application to Mr. William Pochhouse, Secretary, Manchester Corporation Rivers Department, Ship Canal House, King-street, Manchester, on payment of a deposit of £25, which will be retained until the Corporation has come to a decision upon the Tenders received, and will then be returned, provided the contractor shall have sent in a bona fide Tender and shall not have withdrawn the same. All inquiries are to be addressed to the Secretary, but cheques for the deposit should be made payable to the City Treasurer.

Tenders, in sealed covers, superscribed "Tender for Sewage Sludge Steamer," must be addressed to the Chairman of the Rivers Committee, Manchester Corporation Rivers Department, Ship Canal House, King-street, Manchester, and be delivered not later than Saturday, the 18th day of June, 1932.

By Order,
F. E. WARBRECK HOWELL,
Town Clerk.

19th April, 1932. 8450

Waltham Holy Cross Urban

DISTRICT COUNCIL.
FOR SALE.

The Council invite OFFERS to PURCHASE TWO CORNISH BOILERS, 10ft. by 4ft., SMALL HORIZONTAL and VERTICAL STEAM ENGINES, 4in. and 5in. CENTRIFUGAL PUMPS and SHAFTING, &c., until recently in use at the Sewage Works.

Further particulars from the undersigned.

Offers to be made to F. C. E. Jessopp, Esq., Clerk of the Council, High Bridge-street, Waltham Abbey, by 5 p.m. on Monday, 16th May, 1932.

W. C. HOLLOWAY,
Surveyor.

Town Hall,
Waltham Abbey. 8460

The Engineer

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PUBLIC NOTICES.

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF STORES, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of the undermentioned STORES and SERVICES, &c., for periods of 6 and 12 months, commencing 1st June, 1932.

Tender No.
1.—Bricks, Fire-bricks, Cement, &c.
8.—Iron and Steel.
9.—Bolts and Nuts, Screws, Files, Shovels, Steam Tubes, &c.
12.—Fuel Oil, Oil (Lubricating), Kerosene, Motor Spirit, Greases, Tallow, &c.
19.—Iron, Brass, Gun-metal, and other Castings.
20.—G.M. Stop Cocks and Ferrules, Outlets and Caps for Fire Hydrants.
22.—Timber.
23.—Maintenance of Weighing Machines.

Tenders must be submitted on the official forms, which may be obtained on and after Friday, 29th April, 1932, from the Chief Engineer, by personal application at the offices of the Board (Room 155) or upon forwarding a stamped addressed sack envelope.

Applicants should refer to the number of the Tender for which forms are required.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board," and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Wednesday, 18th May, 1932.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
175, Rosebery-avenue, E.C. 1,
23rd April, 1932. 8464

London County Council.

Qualified MECHANICAL ENGINEER (Temporary), age 25-35, REQUIRED in Chief Engineer's Department. Must be experienced in the preparation of plans, specifications, and estimates for the installation of steam boilers, engines, pumping plant, central kitchen apparatus, and laundry machinery in large hospitals and institutions.

Rate of pay (subject to temporary reduction) £4 10s. to £5 10s. a week, according to qualifications.

Applications must be made on the official form obtainable by sending stamped addressed foolscap envelope to CHIEF ENGINEER, The Old County Hall, Spring-gardens, S.W. 1, to whom applications, together with copies of recent testimonials, must be returned by 6th May. 8424

PUBLIC NOTICES.

PATENTS AND DESIGNS ACTS, 1907 TO 1928.

Notice is Hereby Given that LOUIS FREDERICK RUDSTON FELL, of 48, De Vere-gardens, Kensington, London, W. 8, SEEKS LEAVE to AMEND the SPECIFICATION of Letters Patent No. 279,193, granted to him for an invention entitled "Improvements in the Fuel Supply Means of Internal Combustion Engines."

Particulars of the proposed Amendment were set forth in No. 2257 of the Official Journal (Patents), published on the 20th April, 1932.

Any person, or persons, may give Notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of publication of the said Journal.

W. S. JARRATT,
Comptroller-General.

8446

Corporation of Durban, Natal

(SOUTH AFRICA).

APPLICATIONS are INVITED for the POSITION of BOROUGH ELECTRICAL ENGINEER to the Durban Corporation, which will become vacant in December, 1932.

The grade for the position is fixed at £1355, rising by annual increments of £37 10s. to £1581 per annum, subject to the operation of the Council's Sedation Scheme, which is based on the cost of living, and the appointment will be in terms of the Council's General Conditions of Service and Leave Regulations, and certificate of medical fitness must accompany each application.

It will be a condition of the appointment that the successful applicant takes up duties on the 1st November, 1932, which is prior to the date of retirement of the present incumbent of the position.

Applicants, whose age shall not exceed 45 years, must have a sound technical and administrative and commercial experience of an Electricity Undertaking.

The candidate appointed will be required to devote the whole of his time to the duties of the office.

Applications, stating age, experience, and qualifications, accompanied by copies of recent testimonials, must be delivered to the undersigned not later than Friday, the 15th July, 1932.

Personal canvassing of Councillors is strictly prohibited, and proof thereof will disqualify a candidate for the appointment.

A. O. JONES.
Town Clerk.

Town Clerk's Office,
Durban, Natal, South Africa. 8463

PUBLIC NOTICES.

County Council of Middlesex.

APPLICATIONS are INVITED as follows:—

NOTE.—All persons appointed in a permanent capacity will be required to undergo such medical examination as the Council may direct, and, subject to passing the same, to contribute towards the County Council's Superannuation Fund, unless subject to the Poor Law Officers' Superannuation Act, 1896.

SALARY ABATEMENTS.—All appointments over the value of £150 per annum (including value of emoluments) are subject to the following temporary abatements, namely:—

For the first £150 per annum, no abatement.
For the next £100 per annum, 2½ per cent. abatement.

Superannuation contributions and the calculation of superannuation allowances to be on the remuneration as unabated.

AT WEST MIDDLESEX COUNTY HOSPITAL, ISLEWORTH.

ASSISTANT ENGINEER (Non-resident). Wages £4 per week with overalls. Candidates must have a thorough knowledge of electrical and general engineering works; be fully conversant with the construction and working of steam boilers, pumps, heating, hot and cold water supplies, kitchen plant, sterilising apparatus, bells, telephones and wireless equipment, sanitary and fire appliances, lifts and workshop tools. They must be capable of taking charge of the engineering plant during the absence of the Chief Engineer. The Council will require evidence that the candidates have served an apprenticeship with a reputable engineering firm.

Applications, stating age, qualifications and experience, with copies of not more than three recent testimonials, must be received by the undersigned not later than May 4th. (P.A.W./56).

By Order,
ERNEST S. W. HART,
Clerk of the County Council.
Guildhall, Westminster, S.W. 1. 8465

BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION.

APPLICATIONS are INVITED for the POSITION of DIRECTOR.

The duties call for Organising and Administrative Ability, together with a wide knowledge of Research and of the Non-ferrous Industry.

Salary not less than £1500.

Applications by letter to:

THE CHAIRMAN OF THE ASSOCIATION,
THOS. BOLTON, Esq., 168, Regent-street, W. 1.
8473

SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

Box No. 8343.—Position filled, applicants thanked.

CITY OF BIRMINGHAM.

APPLICATIONS are INVITED for the POSITION of GENERAL MANAGER of a Works specialising in the production of Non-ferrous Alloys in all forms. Applicants should have a sound knowledge of Non-ferrous Metallurgy, and when applying should state age, qualifications, and give full details of their education and previous experience. The salary to be paid is about £1500 per annum, and preference will be given to applicants who have held a similar executive position.—Replies to be addressed 8461, The Engineer Office, and should be received not later than May 7th next. 8461 A

ENGINEER WANTED for Supervision of Garrett Engine and Boiler Set in S.E. London.—Address, stating experience, wages, &c., P2367, The Engineer Office. P2367 A

WORKS MANAGER, Who Has Made Pumps and Pumping Machinery on production lines, with modern equipment.—Address, 8471, The Engineer Office. 8471 A

WANTED.—DRAUGHTSMAN; Must be Experienced in Design of Machinery such as Textile or other Light Design.—Apply by letter, stating experience and salary required, to SOUTHERN UNITED TELEPHONE CABLES, Ltd., Dagenham Dock, Essex. 8474 A

DRAUGHTSMAN REQUIRED, to Take Charge of Drawing-office of Large Works. Only those with first-class experience in similar position in a Paper Mill need apply.

Applications should furnish fullest information regarding age, experience, and salary required.

Address, 8469, The Engineer Office. 8469 A

FOREMAN REQUIRED for Light Engineering Assembly Shop. Must be used to quantitative production. Good disciplinarian. Experience essential.—Address full details, 8467, The Engineer Office. 8467 A

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The Engineer

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This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

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Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

Postal Address, 28, Essex Street, Strand, London, W.C. 2.
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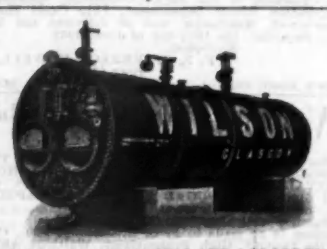

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A Seven-Day Journal

Subsidies to Civil Aviation in Belgium.

ACCORDING to a ministerial statement in the Belgian Chamber of Deputies last week—April 21st—the subsidies paid by the Government for the encouragement of civil aviation are approximately as follows:—For an aeroplane of Belgian design and construction, the subsidy amounts to 50 per cent. of the value of the machine without its motor, up to a limit of £229, and an extra £57 for the motor. For an aeroplane of foreign design, but of Belgian manufacture, the corresponding subsidies are £75 and £19 respectively. Every new pilot belonging to a civil aviation club is awarded a bonus of 50 per cent. of the cost of his flying warrant, with a maximum of £29. Civil aviation clubs are also awarded subsidies in respect of the number of flying hours of their members, according to the following scale:—For flights on an aeroplane entirely of Belgian design and construction, 23s. per hour; for flights on an aeroplane entirely Belgian except for the motor, 17s. per hour; for flights on an aeroplane of which the motor only is entirely Belgian, 11s. 6d. per hour; for flights on an aeroplane of foreign design, but built in Belgium under license, 5s. 8d. per hour. The above sums have been converted into English currency at the old rate of 175f. to the pound sterling. At the present rate of exchange, the English equivalents would be about 31 per cent. greater than the amounts given. The encouragement given, indirectly, to Belgian manufacturers to build machines to their own designs is very noticeable.

Mersey Docks Improvements.

FURTHER improvements to the Mersey docks were brought into use when the Lord Mayor of Liverpool opened a new bridge and admitted water to a new dock last Friday, April 22nd. The new wet dock, named the Trafalgar Dock, has been constructed on the site of the old Clarence half-tide dock. The length of quayage brought into use by the opening of the new dock is 3231 lineal feet, the water area inclusive of that provided by the new Clarence graving dock being over 7 acres. A new passage, 60ft. in width, with a depth of water over the sill of 26ft. 4in. on spring tides, has been constructed to connect the new dock and the Salisbury Dock, and the bridge of rolling bascule type which the Lord Mayor opened crosses this passage. The new dock is equipped with transit sheds of a total length of 2195 lineal feet, and a floor area of 13,316 square yards, and railway communication is provided on all the quays. The new graving dock is 443ft. 10in. in length, with an entrance width of 52ft., and the maximum depth of water over the blocks of 22ft. 4in. on spring tides. It is capable of accommodating the largest vessels using the Central dock system. The pumping plant is capable of discharging water at the rate of 36,000 gallons per minute. Besides the works mentioned, the passage between the Trafalgar Dock and the West Waterloo Dock has been widened and a rolling bascule bridge built over it, and the passage between the Waterloo Dock and Princes Dock has been deepened. The two new bridges each have a clear span of 60ft., a roadway width of 24ft., and two footways each 5ft. wide. They are operated electrically, the machinery being interlocked to ensure a proper sequence of operations. The construction of the new dock completes the canalisation of the North and Central systems of docks, and the largest vessels using the Central docks will now be able to enter the Gladstone Dock at any state of the tide, and obtain access to the whole of the Central dock system. The works were carried out by the Dock Board under the direction of the engineer-in-chief of the Mersey Docks and Harbour Board. The superstructures of the bridges were erected by Dorman, Long and Co., Ltd. The work is estimated to cost about £1,000,000.

Idle Tonnage.

THE quarterly returns prepared by the Chamber of Shipping show that on April 1st there were laid up in the ports of Great Britain and Ireland 734 vessels, totalling 1,800,000 net tons This total compares with 728 ships of 1,966,417 tons on January 1st, and shows a decrease on tonnage laid up of 166,417 tons, or 8·5 per cent. Compared with figures for April 1st of last year, a decrease of 119,786 tons, or 6·2 per cent. is shown. The totals referred to include fourteen vessels of foreign ownership, aggregating 26,671 tons, so that the actual total of British tonnage laid up on April 1st, 1932, in United Kingdom ports really amounts to 1,772,329 net tons, and represents about 2,750,000 gross tons, or about 4,500,000 deadweight tons. The figures do not include any British ships laid up in foreign ports. Out of the totals given, 276 vessels of 744,896 net tons have been laid up for a year or longer. The ships laid up include fifty-seven oil tankers, of which sixteen are motor tankers, in addition to fourteen other motor ships and ten sailing ships. Bearing on the subject of obsolete tonnage, Herr D. Schumacher, one of the principals of the Schuldt Shipping Company, of Flensburg, has recently published in the German shipping journal *Hansa* a new scheme for the scrapping of obsolete tonnage, in which he suggests that the principal shipping countries should agree together to scrap all ships between 1000 and 8000 gross tons which are over twenty years old, compensation being being paid to their owners. If this were to be done, the author says, almost all the shipping now laid up in various parts of the world would be done away with. A permanent advantage would be gained if the redundant tonnage of the world could be reduced to such proportions as would allow the operating tonnage to earn profits.

Portsmouth Electricity Undertaking.

AT a cost of £50,000 the Portsmouth electricity undertaking has installed new switchgear to meet the conditions imposed by the increased capacity of its generating station and the prospect of interconnection with the "Grid." The equipment consists of twenty-eight English Electric compound filled metal-clad units for operating at a pressure of 6600 volts. Each unit has a rupturing capacity of 500,000 kVA, and is equipped with the usual protective devices. The whole of the gear, which is electrically operated, is accommodated in a new switch house, included in the £50,000 contract. A control room on the third floor of the switch house contains a semi-circular desk type control board, by means of which the attendant can control the power station generators and communicate with any part of the system or engine-room by telephone or signal. A larger upright board in the same compartment carries the control apparatus for synchronising and for the feeder circuits, together with the necessary instruments. A separate compartment in the control room contains a battery for the supply of the control circuits and a complete charging equipment is installed adjacent to the control boards. Within a few weeks this control room will deal with the supply over the area of 182 square miles covered by the undertaking, which extends as far as Salisbury, Petersfield, Eastbourne, and Arundel. Speaking at the inauguration ceremony last week, Mr. B. Handley, the chief engineer of the Portsmouth undertaking, said that within the past twelve years the output, including units sold to other undertakers, showed an increase of 1000 per cent., or 800 per cent. excluding bulk supplies and tramways.

A "Back to Coal" Deputation.

A DEPUTATION from South Wales was received last Thursday, April 21st, by Mr. Baldwin, to discuss the "back-to-coal" movement and the reversion of the British Navy to coal fuel. The deputation included representatives of the Cardiff Chamber of Commerce, Welsh coalowners, the South Wales Miners' Federation, the South Wales Coal Exporters' Association, and other interests. The Lord Mayor of Cardiff, who headed the deputation, dealt with the great amount of unemployment in Cardiff and the distress caused thereby. Other spokesmen pointed out that the number of persons employed in the coal mines of South Wales to-day was 148,000, compared with 233,000 in 1913. Before the war 50 per cent. of the exports of coal from the district was used for steam-raising purposes, mainly bunkering of cargo and other steamers. The advance that had been made in the economic utilisation of coal was also stressed. Twenty years, it was pointed out, had elapsed since a coal-fired man-of-war had been constructed. It was suggested that at least one might be built as an experiment. The deputation made the request that a commission should be set up to examine the whole question. Mr. Baldwin undertook to lay the views of the deputation before the Prime Minister when he returned from abroad, and invited a few of its members to meet the Fuel Research Board and put before it any proposals as to suitable experiments that might be carried out.

The New Cunard Liner.

RENEWED attention has been drawn to the question of the completion of the new Cunard liner by Mr. D. Kirkwood's recent question to the President of the Board of Trade asking whether, in view of the need for stimulating a revival of the shipbuilding and ancillary industries, he would set up a Committee of Inquiry into all possible methods of affording assistance to the Cunard Company, in order to enable the constructional work on liner "No. 534" at John Brown's Clydebank yard to be resumed. In reply to this question, Mr. Hore-Belisha, Parliamentary Secretary to the Board of Trade, said that while the Government was quite appreciative of the point of view represented by those interested in the matter, there seemed only two courses open. Either the Government should finance the transaction or the company should finance it itself, and there seemed to be no reason for relieving the company of its autonomy or its responsibility. On the other hand, in a letter to *The Times*, Sir George Hunter, of Swan, Hunter and Wigham Richardson, Ltd., urges the Government to advance a loan to the Cunard Company at a low rate of interest for the completion of the vessel. He points out that British shipowners are finding it difficult to hold their own, and maintain themselves in the face of State-aided foreign competition. The case of the Cunard liner, he holds, is an exceptional one, the ship being required to maintain the prestige and serve the vital interests of Great Britain and the British Empire. The mercantile marine should be supported and defended, and such a proposed loan, he holds, would not be a subsidy, but a legitimate business investment.

The British Locomotive Industry.

AN interesting survey of the future of the British locomotive industry was made on Wednesday last by Sir Sam Fay, who presided at the annual meeting of Beyer, Peacock and Co., Ltd. Speaking of last year's results, he said that lack of work was not due to the company having failed to secure orders in the face of competition, but because, owing to the necessity for economy on railways throughout the world, the inquiries for locomotives had been few and far between. During 1931 the company received invitations to tender for only one-fifth of the number of locomotives which were inquired for in the preceding year. A satisfactory proportion of the orders placed, such as they were, had, however, been obtained by the company, but they had not been sufficient to keep the shops fully employed. It could only be a question of time, Sir Sam continued, before railways, whose revenues and buying capacities were naturally dependent on the economic conditions of the companies they served, would need to purchase rolling stock in order to meet replacements and traffic requirements. It was also reasonable, he thought, to expect that economy in railway purchasing would lead to accumulation of arrears of demand. If there was to be a return of general confidence, and a revival of traffic on the railways, then many schemes for locomotive renewals and development which perforce had been shelved would come to fruition. As soon as such conditions obtained the British locomotive industry would recover.

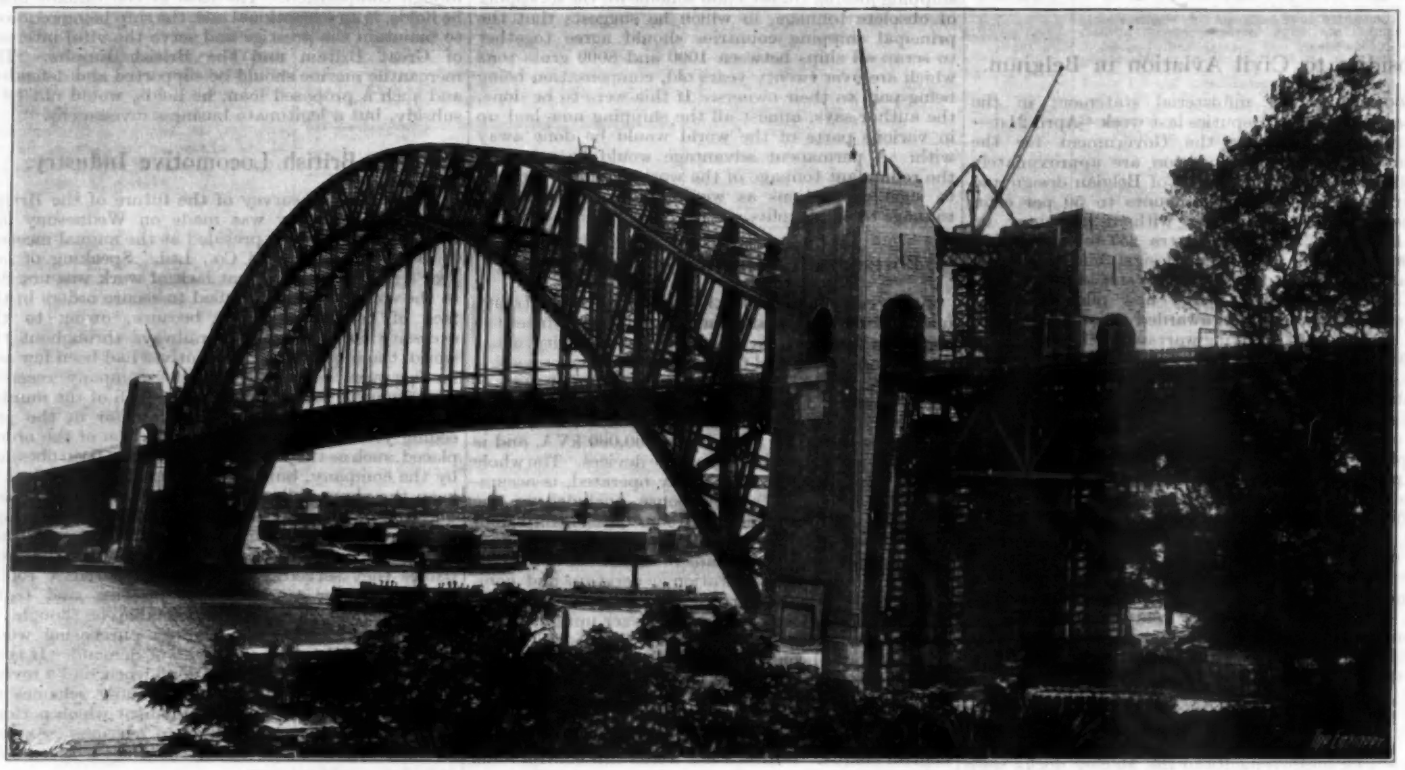
Channel Ferry.

THE Southern Railway Company's Bill, promoted in order to obtain parliamentary authority for the provision at Dover of terminal facilities for a cross-Channel train ferry, was on Tuesday last, April 26th, passed by a Select Committee of the House of Commons, and reported to the House without amendment. It provides for the construction of a dock for the train ferry vessels, a widened quay, and a railway junction with short lines connecting the new quay to the existing lines. In support of the scheme, Sir Herbert Walker stated that the Southern Railway Company had been pressed by the French Railways, which, he believed, had the support of their Government, to establish a train ferry on the short sea route. The ferry, which would require close upon £545,000 for the terminal works, would be designed for goods services, but also so that, if necessary, passenger services could be worked. During the examination of the preamble of the Bill much discussion took place as to the question whether coal trains passing along the sea front, and possible coal dust from them, would prove detrimental to the amenities of the town. For this reason the Bill was opposed by the Dover Harbour Board and the Dover Corporation. The opposing parties and the railway representatives met together in order to see if their differences could be composed, but this was not found possible. A proposal for the limitation of the number of coal trains to fifteen per day was put forward by the railway company, with the suggestion that if the coal traffic should increase to 800,000 tons per year, then some alternative means other than the sea front railway should be considered for the coal transport traffic.

Import Duties.

ON Thursday, April 21st, an interim report of the Import Duties Advisory Committee was issued to Members of the House of Commons, and at the same time a Treasury Order which brought the duties recommended by the Committee into force last Monday was circulated. As far as the engineering industries are concerned, the most important item in the new tariff is the increase of the 10 per cent. duty on semi-finished steel by 23⅓ per cent., bringing the total duty to 33⅓ per cent. *ad valorem*. The Committee recognises that iron and steel present peculiar difficulties, and that a precise tariff treatment can only be decided after detailed examination. For this reason, it has been decided that the new duty on semi-finished steel shall hold for a minimum period of three months, during which its effect will be studied with a view to the establishment of a permanent tariff. In addition to this increased duty on steel, the duty on most classes of machinery has been increased by a further 10 per cent. above the general tariff of the same amount, making 20 per cent. in all. Arrangements will be made to admit certain classes of highly specialised machinery free of duty. The new duties are being freely discussed in manufacturing centres, and the attention of our readers is directed to the letters from our Provincial Correspondents on other pages of this issue.

SYDNEY HARBOUR BRIDGE—APPROACHING COMPLETION



Sydney Harbour Bridge.

No. VII. (*conclusion*).*

The Closing of the Half-arches.

It was necessary to avoid the possibility that the two half-arches would make contact with each other prematurely, as a result of thermal expansion or other possible cause of movement of the structures. The position in this respect was complicated by the fact that some uncertainty existed concerning the amount by which the anchorage ropes would stretch during their prolonged period of loading. To make sure that the half-arches would not make accidental contact before the time was ripe for closing them, it was arranged that a gap, intended to be 40in. wide, should separate the ends of the lower half-chords after they had been completely erected. In order to produce this gap, the half-arches were erected, as already noted, with a slight upward tilt, amounting to a shorewards displacement of 2ft. 6in., as measured at the tops of the end posts.

Early in August, 1930, the half-arches had reached the stage at which the closing operations could be begun; that is to say, they had been completely erected with the exception of the central posts 0–1 and the upper chord members 1–3, and their lateral bracing. These posts and members were not to be added until the two half-arches had been lowered round the main bearing pins as hinges and the ends of the lower half-chords had made final contact. On the date referred to, the 128 anchorage ropes attached to each half-arch were sustaining the weight of the half-arch and the creeper crane at its outer end. That weight was equivalent to about 14,000 tons at a leverage of 350ft., and produced in each of the anchorage ropes a tension of about 108 tons. In order to close the gap of 40in. between the ends of the lower half-chords, each half-arch had to be turned on the bearing pins by an amount which would produce a forward movement of 20in. at its end. That movement, as a geometrical consequence, involved a forward movement of 10in. as measured at the tops of the end posts. Since both the end posts of each half-arch had to move through that distance, the closing process necessitated in effect the lengthening of each of the anchorage ropes by 20in.

The method adopted for producing this effective lengthening of the ropes will be gathered from Fig. 36 *ante*, which is here reproduced. The 3in. screwed rods passing through the rope sockets extended, in the pre-closing state of the anchorage, about 32in. beyond the saddle, which bore against the link plate pins. A temporary crosshead was provided to pass on to the free ends of the screwed rods and between it and the saddle a hydraulic jack of very compact design and working at a pressure of 4 tons per square inch, could be set up. By means of this jack the pull of the rope could be transferred temporarily from the nuts behind the saddle to the nuts behind the crosshead. As a consequence, the saddle nuts could be run back by some settled amount, actually 3in., and then on the release of the pressure in the jack, the load could be slowly re-transferred from the crosshead nuts on to the saddle nuts in their new position.

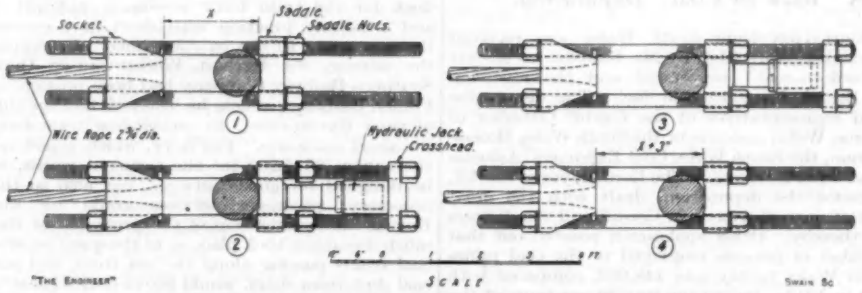


Fig. 36 (Reproduced)—Anchorage Rope End Connection

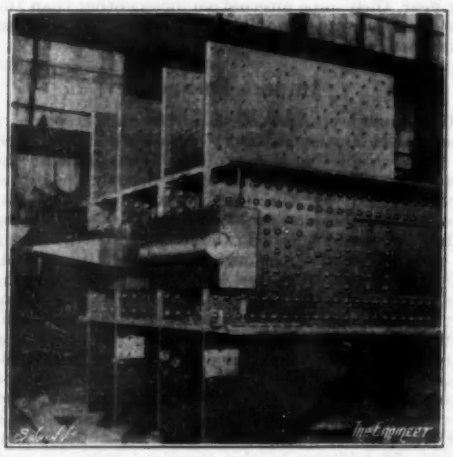


Fig. 46—Pilot Pin and Bearing Pin

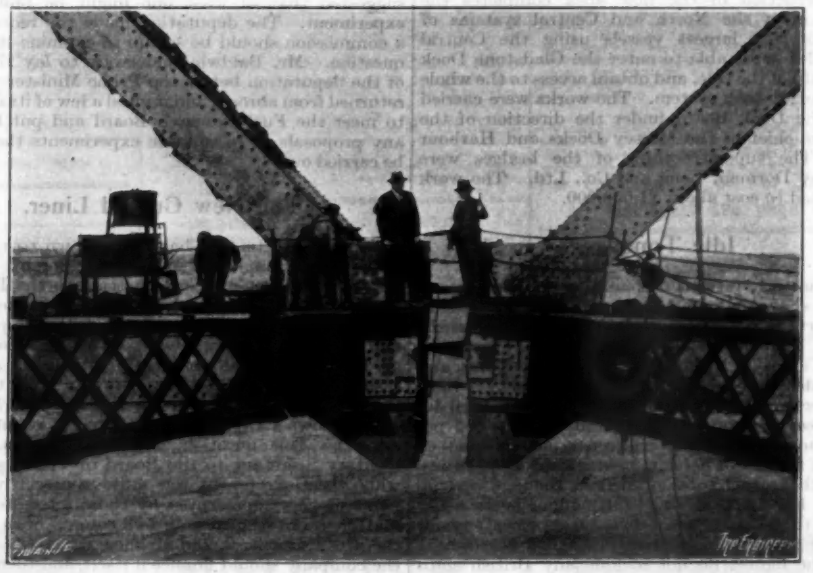


Fig. 47—Gap in Lower Chord during Closing Process

* No. VI. appeared April 22nd.

Four hydraulic jacks were provided at each end post in order that while one was in operation the remaining three might be prepared for successive use. It will be noted that this lengthening process did not actually lengthen the rope, and that the true lengthening was represented by the movement given to the saddle nuts on the screwed rods.

When this operation was carried out simultaneously at both ends of the first of the 128 ropes, that rope

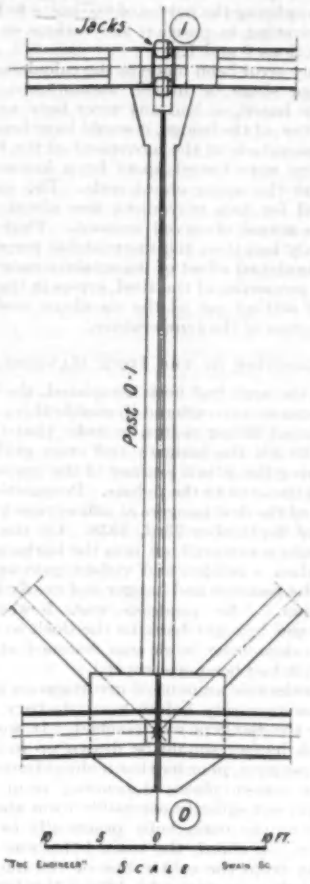


FIG. 48—VERTICALLY DIVIDED POST

contracted by 6in. in its length of 1200ft., and the tension in it was thereby reduced from 108 tons to about 91 tons. The remaining 127 ropes were therefore automatically called upon to take up between them an additional 17 tons of load. Under this extra tension, each of them stretched about $^1/_{20}$in. As a result, each end post moved forward by $^1/_{40}$in., and by so doing produced a horizontal forward movement at the end of the half-arch of twice that amount, simultaneous operations the gap was reduced by about $^1/_{10}$in., and when the last rope at each end was run out the gap had been reduced by about a foot. The cycle of operations was then begun again at the first rope, and was continued until the gap was closed.

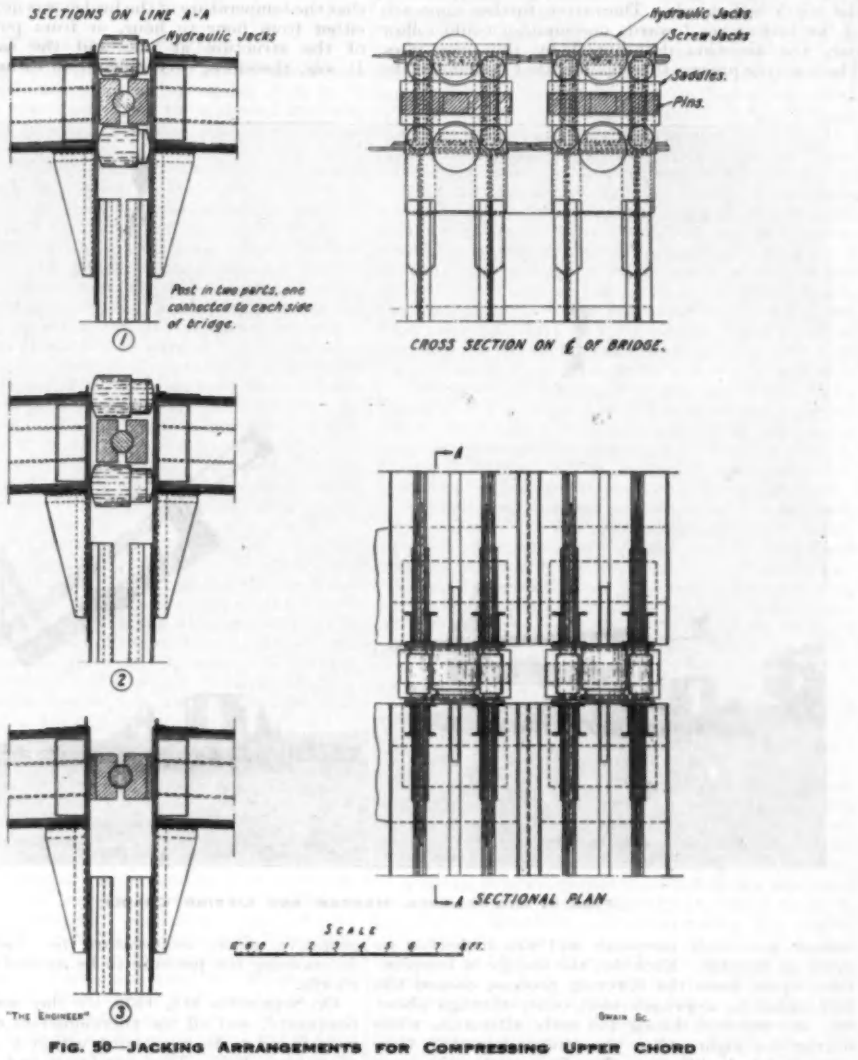


FIG. 50—JACKING ARRANGEMENTS FOR COMPRESSING UPPER CHORD

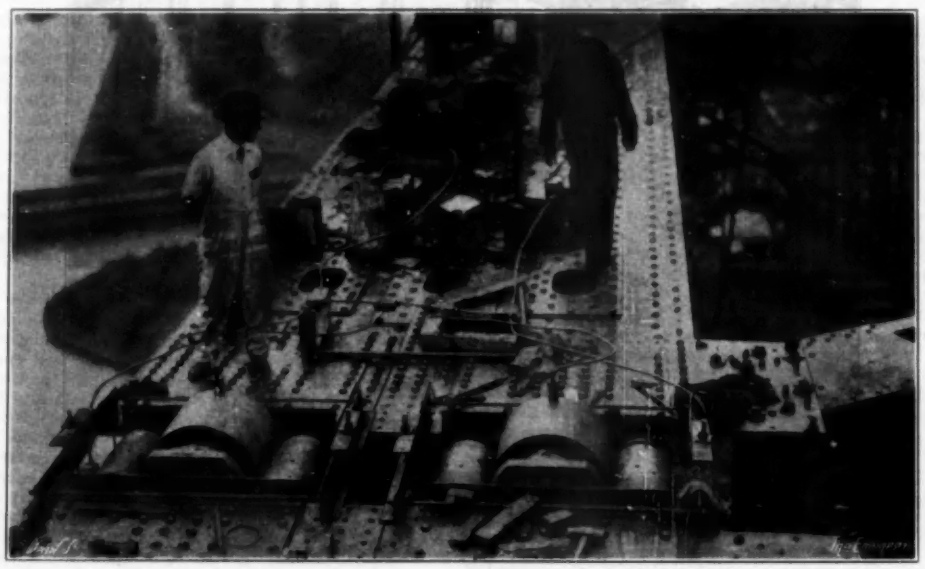


FIG. 49—GAP IN UPPER CHORD DURING COMPRESSION PROCESS

or $^1/_{20}$in. An identical operation was carried out simultaneously on one of the ropes anchoring the other half-arch. As a consequence of these two operations, the gap between the ends of the lower half-chords was reduced by $^1/_{10}$in.

A precisely similar operation was then carried out on a second rope at each shore end of the arch, and resulted in the gap being reduced by another $^1/_{10}$in. The operation was repeated rope by rope until all the 128 ropes had been run out. With each pair of

It should be noted that when the first rope was run out all the remaining 127 ropes stretched by $^1/_{20}$in., and that when the second rope was run out all the remaining 126 ropes stretched by an additional $^1/_{20}$in. Simultaneously, the first rope stretched by a single $^1/_{20}$in. As the succeeding ropes were run out one after the other, those ropes which had still to be run out stretched more and more, and those which had previously been run out began gradually to recover the stretch of which they had been relieved. Just before the 128th rope was run out, it had suffered a stretch of practically 6in. additional to the stretch which it possessed initially. The tension in it had, as a consequence, increased from 108 tons to 125 tons. After it had been run out, all the 128 ropes were again under the initial uniform tension of 108 tons. The second cycle of operations was therefore carried out under precisely the same conditions as regarded the tension in the ropes as the first, and again brought the tension in the last rope up to 125 tons just before it was run out for the second time. It is of interest to note that the ropes were not impaired in any way by their service, and that following their removal and return to England they have been used for various permanent and temporary purposes.

The lowering process was effected with perfect regularity and smoothness, except in so far that the actual movement of the half-arches was found to be considerably affected by the temperature of the structures. The true movement effected by the lowering process could be satisfactorily measured only at the end of the day. As the men operating the lowering arrangements became accustomed to the work, they found it possible to complete an operation in about 15 minutes or forty to fifty operations per day, thereby reducing the gap by 4in. to 5in. The closing of the gap occupied a total time of about two weeks. After contact between the ends of the lower half-chords had been established, the running out of the ropes had to be continued for some considerable length of time before the compression in the lower chord members rose to the value required to make the arch self-supporting without the aid of the anchorage ropes.

Each pair of lower half-chords came together on two 8in. pins, as noted in connection with Fig. 20 in the Supplement published with our issue of April 8th. In order to ensure that the half-chords would come into accurate alignment vertically and horizontally and ultimately meet on these pins, the end of each south half-chord was provided with a centrally disposed pilot pin, 10in. square, and pointed at the end—see Fig. 47. This pin and one of the circular bearing pins are shown in the shop photograph, reproduced in Fig. 46. The pilot pin was jacked forward from a diaphragm between the inner pair of webs of the south chord member and entered a hole in a guide between the corresponding plates of the north chord member. The pilot pins were strong enough to enable the half-arches to support each other in the event of any unexpected disturbance, such as would have been caused by excessive temperature change, exceptionally high wind, or failure of the lowering gear at one end. The arrangement was such that it could have accommodated a divergence of anything up to 4½in. from correct alignment. The actual closing of the lower chords was, however, accomplished without a measurable departure from correct alignment in the transverse direction, and

with a vertical divergence which was not greater than that ascribable to the fact that the temperature effect of the sun was greater on the north half-arch than on the south.

When the gap had been reduced to 8in., the pilot pins were jacked forward to engage the guides in the north half-chords. Thereafter, further approach of the half-arches towards one another could follow only the direction determined by the pilot pins. The lowering process thereupon ceased to demand the caution previously necessary and was expedited as much as possible. Each day the change of temperature, apart from the lowering process, caused the half-arches to approach each other through about 6in. as measured during the early afternoon, while during the night, when the temperature fell, they separated by a like amount. During the afternoon of August 19th, 1930, the thermal expansion combined with the increased rate of lowering, was bringing the two half-arches together very rapidly, and at 4 p.m. it was found on inspection that they were in actual contact and that the two sides of the bridge had met simultaneously and in perfect alignment. It was realised that the half-arches must separate again as the bridge cooled after sunset. The rate of lowering was therefore still further increased, and at 10 o'clock that night the rate at which the half-arches were being lowered had overtaken the rate at which they were contracting thermally. At that instant the half-arches established permanent contact with each other.

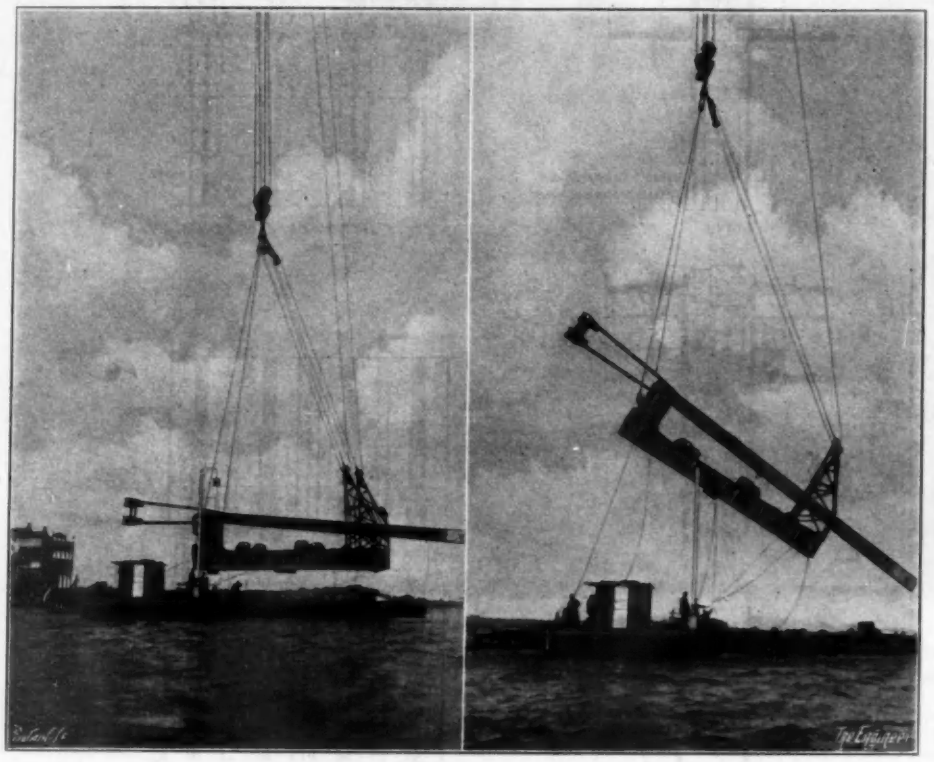
During the succeeding three weeks the process of releasing the anchorage ropes was continued, and as the ropes became free from tension they were dismantled and removed. Within the same period work was proceeding on the erection of the final truss members, namely, the central posts 0–1 and the top chord members 1–3. The next process to be carried out, the compression and joining of the upper half-chords, made it necessary that each of the posts 0–1 should be divided vertically—see Fig. 48—and that each half-post and the upper chord member 1–3 which it supported, should be attached solely to the corresponding half-arch. With these parts so erected there was left a gap of about 2ft. 6in. between the ends of the upper half-chords—see Fig. 49. In each of these two gaps four hydraulic jacks were set up—see Fig. 50—each capable of exerting a maximum pressure of 1000 tons. In addition, eight 9in. diameter screw jacks were disposed in each gap to follow up and make good the movement effected by the hydraulic jacks. These screw jacks also acted as safety devices to meet any failure on the part of the hydraulic plant. This precaution was rendered desirable because the limited space available for the hydraulic jacks made it necessary to operate them at a very high pressure—4 tons per square inch.

During the erection of the half-arches the upper chords were under tension. Following the closing of the lower chords, they passed into a state of slight compression. In order that they should take their proper share of the load, it was necessary that they should be put under a calculated amount of compression before they were finally connected up. The precise pressure which the jacks should apply to the upper chord to meet the requirements of the designers depended upon the temperature of the structure at the moment at which the operation was carried out. Careful records of the temperature of the bridge at various points had been made during a period extending over several weeks. In Sydney the temperature changes continually throughout the day and night. From the records it appeared that the temperature of the bridge was never constant, either from hour to hour, or from point to point of the structure at one and the same instant. It was, therefore, very difficult to estimate a representative mean temperature for the purpose of determining the pressure to be applied to the upper chords.

On September 8th, 1930, the day was cloudy and temperate, and all the thermometers on the bridge were found to be registering within a degree or two of 60 deg. Fah. That condition had not occurred previously and it was recognised that it might not occur again for weeks. A few of the anchorage ropes still remained to be released and removed, but, in spite of that fact, it was decided to seize the opportunity and to proceed with the jacking operations while the conditions were so favourable. During the afternoon of the day named, parties of observers took repeated observations of the temperature and measurements of the tension in the remaining anchorage ropes. By 4 p.m. the necessary data had been collected, and from the figures so presented it was calculated that the force required to be exerted by the jacks on each arch truss was 3250 tons. A force closely approaching this value had been tentatively applied, and within a few minutes after the correct value had been calculated, it was in existence and the screw jacks had been opened out to follow the movement of the hydraulic jacks.

On the following day carefully machined filling slabs were inserted behind the saddles for the bearing pins through which the compressive stress was finally to be transmitted from one upper half-chord to the other. The jacks were then removed and work was begun on splicing the halves of the posts 0–1 together, and on riveting in position the various cover plates at connections 0 and 1.

Had any error been made in the calculations during the design stage or in the assumptions on which they were based, or had any error been made in the manufacture of the bridge, it would have been revealed by the magnitude of the movement of the half-arches when they were forced apart by a known pressure applied at the upper chord ends. The mean figure calculated for this movement was about ½in. more than the actual observed amount. That difference is certainly less than the unavoidable error produced by the combined effect of uncertainty concerning the physical properties of the steel, errors in the manufacture and setting out of the members, and errors in the estimates of the temperature.



FIGS. 51 AND 52—DECK HANGER AND LIFTING CRADLE

Erection of the Deck Hangers.

When the arch had been completed, the jibs of the creeper cranes were altered to enable them to operate at a reduced lifting radius, in order that they might be able to lift the hangers and cross girders of the deck during the return journey of the cranes from the crown of the arch to the pylons. Preparations for the erection of the first hangers at connection 0 were completed by September 23rd, 1930. On that date the first hanger was towed out into the harbour ready for lifting when a sudden and violent gale arose, which caught the pontoon and hanger and nearly led to their destruction. The pontoon was, however, safely secured and brought back to the dock at the shops, and two days later work was resumed at the point at which it had been interrupted.

A considerable amount of investigation and experiment was necessary before a satisfactory method of erecting the hangers was reached. It was essential that each hanger should be drawn up in a perfectly vertical position, in order that it should enter correctly the four gusset plates depending from the lower chord and not directly accessible from above. With the falls of the main hoist practically touching the flanges of the chord, the main hoist was still about 8ft. away from the centre line of the hanger. This difficulty was overcome by lifting the hangers on a specially devised "cradle," which incidentally also served to support these slender members, the longest of which measured 190ft. The cradle—see Figs. 51 and 52—was of steel, and supported the hanger over about half its length. It was formed with projecting arms at its ends at right angles to its base, and was placed on the erection pontoon with the arms pointing upwards. In that position the hanger was connected by a 7in. pin to the shorter of the cradle arms, and was allowed to rest freely between the longer. The shorter arms were then connected to the main hoist of the creeper crane. From the ends of the longer arms, ropes were led to pulleys attached beneath the main hoist, then back to pulleys at the end of the longer arms, and finally to the jigger hoist of the creeper crane equipment. This three-part purchase system was adopted in order that the pull required to be exerted by the jigger hoist should be well within the

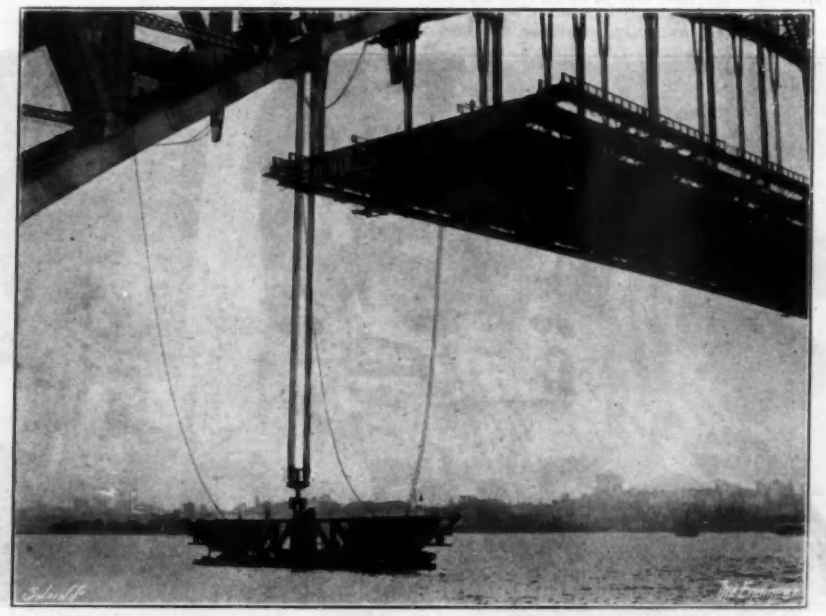


FIG. 53—ERECTION OF THE DECK — LIFTING A CROSS GIRDER

limit of its capacity, namely, 25 tons. The greatest weight to be lifted, consisting of the cradle and the longest hanger, was about 90 tons, and the connections were such as to ensure that in all positions the greater part of this weight was borne by the main hoist.

The cradle and hanger were lifted horizontally off the erection pontoon by the combined action of the main and jigger hoists. After they were clear of the pontoon—Fig. 52—the cradle was raised by the main hoist, while the jigger hoist was lowered away, with the result that the cradle was tilted and finally brought into such a position that the hanger was vertical, and all the weight was being taken on the main hoist. In this condition the hanger was suspended solely by the 7in. pin, while the cradle was hanging away from the vertical, and was automatically balancing the hanger at the required distance of 8ft. from the main hoist. The hanger and cradle were thereupon drawn up vertically until the hanger end entered the gusset plate connection on the underside of the lower chord. The connection having been made, the cradle was detached from the hanger and lowered down vertically until sufficient room was available to restore it to the horizontal position by bringing the jigger hoist again into action.

Erection of the Deck.

After each pair of hangers had been riveted to the lower chord gusset plates, the cross girder to be connected to their lower ends was hoisted into position. These cross girders were 160ft. long and weighed up to 110 tons. They are connected to the hangers, as previously noted, by means of pins, 14in. in diameter and 3ft. in length. To facilitate their insertion these pins were provided with pilot heads and were carried on temporary stages attached to the sides of the cross girders. The pins rested on roller frames, and were arranged on the stages in a position ready for driving home as soon as the cross girder was in correct engagement with the hangers.

The centre cross girder, beneath connection 0, was lifted by both the creeper cranes working in conjunction, and was therefore readily kept in the correct alignment to engage with the hangers. After its pins had been driven, wire rope guys were carried from its points of attachment to the hangers to points on the arch structure with the object of imparting rigidity in all directions to the hanger and cross girder system. The rest of the hangers were erected by the two creeper cranes working separately. As each was erected, it was secured temporarily by a light strut at each end to the cross girder previously erected. In Fig. 53 we illustrate the operation of lifting a cross girder off the pontoon.

Before the crane was moved from one position to the next, all the deck material for the panel being dealt with was lifted into position, and as the work proceeded additional longitudinal and lateral guys were set up to tie the deck structure temporarily to the lower chords of the arch. In a number of cases the deck structure was beyond the reach of the creeper crane. The pieces concerned included the chord members of the deck lateral bracing system, the footway spans and the painting gantry girders lying vertically beneath the main arch chords. To deal with the hoisting of these pieces a horizontal lifting girder was formed from a pair of the deck structure railway stringers, which were braced together to form a box sectioned member, 60ft. long by 7ft. 6in. wide. This beam was slung by means of four straps in an out-of-balance position. The member to be lifted was attached to the shorter end of the beam, and its added weight caused the beam to assume a substantially horizontal position. The member could therefore be lifted and placed in position at some distance beyond the normal reach of the main hoist.

During the first month's work on the deck structure seven panels of the deck were erected and riveted. On February 17th, 1931, the closing stringers between cross girders 20 and 22 were erected, and for the first time connection between Dawes Point and Milsons Point was established at deck level.

Concluding Operations.

Following the closing of the half-arches and the removal of the anchorage ropes, the link plates and their pins were detached and lowered. The creeper cranes had meanwhile been travelling back from the crown of the arch and erecting the deck structure, and had finally arrived at the end posts. By that time the construction of the upper parts of the pylons had advanced to such an extent that it was impossible to reconstruct the ramps on their decks, and thereby return the cranes to the points from which they started. The creeper cranes were therefore dismantled while they were standing on the upper chords of the arch adjacent to the end posts. To effect the dismantling, 25-ton derrick cranes were erected on the deck of the bridge between the pylon towers, and these cranes in turn were dismantled by the 7-ton cranes working on the pylon masonry. The removal of these light cranes formed the last operation in the construction of the bridge. On page 466 we illustrate the bridge as seen from Milsons Point during these concluding stages.

With the exception of that reproduced on page 314 of our issue of March 18th, all the photographs used to illustrate this series of articles are the property of the New South Wales Government, to whom Dorman, Long and Co., Ltd., desire to express their thanks for permission to allow their reproduction.

Recent Locomotive Performance on the L. and N.E. Railway.

By a Contributor.

No. II. (*conclusion*).*

With Other "Pacifics."

The last by no means exhausts the fine runs I have enjoyed behind the pioneer, but unless it is to be thought that this is an engine to be classed by itself, I now quote like performances by others of the fraternity.

No. 2554, "Woolwinder," with 505 tons, passed Finsbury Park in 6 min. 43 sec., Wood Green in 10 min. 6 sec., and then made an excellent climb to Potter's Bar with a minimum of 42·8 miles an hour, passing the summit in 20 min. 7 sec. Near Hatfield engineering works in progress necessitated a reduction of speed, so that we were 41¼ min. clearing Hitchin, 32 miles. On the descending gradients 78·9 was the highest speed recorded, and 54 miles were covered in the hour from the start, in spite of the delay mentioned, with a minimum of 62·5 at the 52nd mile-post, whilst we averaged 69·7 miles an hour from Hitchin to Huntingdon, passing the latter station in 64¼ min. for the 58¾ miles. We ascended to Leys summit with a minimum of 47·8 and reached a speed of 75 on the subsequent descent to Holme. Mile-post 72 was passed in 77 min. 10 sec., and Peterborough reached in 82½ min., the last 44¼ miles having occupied 41 min. The net time for the journey was 80¼ min.

Leaving Peterborough we passed Tallington in 11¼ min., Essendine in 15½ min. and ascended the 1 in 200 with a minimum of 49·4 miles an hour, rose to 51·7 and then fell to 45 at the 99¼ mile-post, but recovered to 46·3 miles an hour on passing the summit at Stoke Box in 28 min. 38 sec. After Great Ponton the running was very restrained. Grantham, however, was passed in the excellent time of 34¼ min. and the running thence was almost identical with that of the last-mentioned performance of "No. 4470," except that finally we encountered more severe signal delays, the net time on this run to Doncaster being 85 min.

No. 4478, "Hermit," on a day when the atmospheric conditions were far from ideal, had the exacting load of 530 tons to haul from Peterborough to Grantham in 36 min., and did not quite succeed. The start was very carefully negotiated with only one slip, and in less than 5 miles we attained 60·8 miles an hour; but at Tallington, passed in 12 min. 5 sec., this speed had fallen to 58·4, and 55½ at Essendine. We required 16 min. 10 sec. to pass the latter station, and despite the somewhat low speed here we ascended to Corby with no lower rate than 46·3 miles an hour and recovered on the easier gradients to 50 miles an hour; then a splendid ascent of the final and steeper climb was made with a minimum of exactly 45 miles an hour, Stoke Box being reached in 30 min. A rapid descent followed and had we made a normal finish at Grantham, we should just have kept time, but on approaching the station the driver, undoubtedly having the greasy state of the rails in mind, ran extremely cautiously to the stop at the end of the platform; it certainly requires careful handling to fit these huge loads to platforms of insufficient length, and we exceeded our schedule by 52 sec. in consequence.

Here the load was reduced by 30 tons and the driver with a modest 500 tons recouped the slight loss by a splendid run to Doncaster, covering the 50½ miles start to stop in 50 min. 39 sec. The 14½ miles to Newark were run in 15 min. 41 sec., and the next 7½ miles of level in 6 min. 33 sec. Then followed a good ascent to the 134th mile-post with no lower speed than 51·7 on the 1 in 200 and a recovery to 52·3 at the summit, this fine work resulting in the excellent time of 32 min. 19 sec. for the 33 miles to Retford, the time of 17 min. 38 sec. for the 18¼ miles from Newark being one of the best I have noted for this length and direction. Thence on to Scrooby we attained 70·3 miles an hour and "topped" the Piper's Wood rise at 57·6. The time from the platform ends at Grantham to the southern end of Doncaster platform was 49 min. 44 sec., but again we ran to the stop much slower than usual, so that the gross time was as stated, a gain of 3¼ min., yet had we been enabled to finish in the usual manner the time would probably not have been more than 50 min., as Rossington—45¼ miles—was passed in 44¾ min.

With the substantial load of 516 tons empty, or close upon 550 tons full, the train being well loaded, No. 4472, "Flying Scotsman," seemed to keep time with ease on the moderate timing of 87 min. to Peterborough. With this sixteen-coach train Finsbury Park was passed in less than 6¼ min., and Wood Green 9 min. 40 sec. From there the 7¾ miles to Potter's Bar occupied 9 min. 57 sec., the "hiss" of the safety valves on this portion of the journey showing that there was no lack of steam, and 45 miles an hour was the minimum speed consistently maintained from New Barnet to the summit. At Hatfield the rate was 75, that station being passed in 5 sec. under 25 min., a fine time for such a load. The minimum speed at Woolmer Green was 54·8 miles an hour, but the engine then appeared to be eased, for we fell to 50 at Knebworth station; even so, we were through Hitchin in 39 min. 12 sec. On the falling gradients the running was quite decorous, no higher rate than 76·2 miles an hour being recorded. The running was, however, very consistent, and 57 miles had been covered in 60 min. 52 sec., when speed had to be reduced to 15 miles an hour for engineering work in progress. That, of course, spoilt the ascent to Leys, as we passed Huntingdon at only 30 miles an hour, the time to this station being 63½ min. At the 62nd mile-post the speed had increased to 42·8 miles an hour, and then with no higher rate than 70·3 at Holme, we reached Peterborough in 83 min. 3 sec., or 80½ min. net, a saving of 6½ min.

Continuing with the load unchanged, and with 37 min. allotted for the journey to Grantham, we started without a slip, but did not reach the mile a minute gait until Tallington, passed in 12 min. 5 sec., and we fell to 59·2 at Essendine, in this instance requiring 16 min. exactly. I should have mentioned that throughout the journey we had to face a moderate N.W. wind, thus there was no help from the elements. On the rise of 1 in 200 the absolute minimum was 46·3 miles an hour, and this had increased to 50 on the subsequent easier gradient when speed had to be reduced to 15 miles an hour for relaying, a section of a mile length being under repair, and so we came right on to the rise at 1 in 178 before the regulator was opened and the engine again given steam, our rate then gradually increasing to 36·6 at the summit, cleared in 30½ min. Despite the delay, we stopped at Grantham with 4 sec. to spare, or 35¾ min. net time.

Incidentally, this run served to show how easily the "Pacific" can deal with the heavy Scotch trains, even if loaded to this extent. The quickest East Coast Express is allowed 121 min. non-stop to Grantham; "Flying Scotsman," with her train on this occasion, performed the journey in 120 min. gross running time or 116¼ min. net, practically 5 min. better than the schedule of the "Junior Scotsman" for the section, and if 3 min. be allowed for the Peterborough stop, by no means an unreasonable handicap, the "Pacific" giving a like performance with the Scotch trains mentioned, could arrive 8 min. early.

As an illustration, No. 2545, "Diamond Jubilee," with 510 tons on the "Junior Scotsman," passed Finsbury Park in 6 min. 40 sec., and Wood Green in exactly 10 min., but at the 6th mile-post was practically stopped for a new bridge and road construction. Then the driver drew the train of fifteen coaches over the obstacle at a walking pace, so that we were in New Southgate station before a real start was made. The speed gradually increased to 33·8, but a fine drizzle of rain commencing, the engine slipped badly and the rate fell to 32. This had increased to 33·3 at Potter's Bar, and in consequence of the serious delay we were 5½ min. late through Hatfield, having taken 32 min. 12sec. Through the station the speed was 70·3 miles an hour, but the filmy state of the rails caused more slipping and the rate fell to 51 at Woolmer Green, the 14½ miles from Hatfield to Hitchin requiring 14 min. 22 sec. From Hitchin we ran magnificently, attaining 81·8 miles an hour on the descent at Three Counties, then the speed receded to 75, but at Biggleswade it had increased to the unusual figure for this spot of 81·8 again. On the slight rise of 1 in 786 at Sandy the rate fell to 69·2, then on the level near Tempsford it increased to 76·2 miles an hour, falling to 67 at St. Neots, from which it increased to 80 miles an hour approaching Offord. It was a unique experience to record three separate rates of 80 or more between Hitchin and Huntingdon, and so 72½ miles an hour was averaged over this section, the time being 22 min. 10 sec. Onwards to Leys we fell to 53 miles an hour, except for the last quarter, when the rate was exactly 50. Near Holme a brief maximum of 77½ miles an hour was noted, and we were through Peterborough at the usual reduced speed in 85 min. 49 sec., the allowance being 86 minutes, and so to schedule, leaving a fraction over 35 min. for the final 29½ miles of adverse gradients to Grantham. This was more than achieved by reaching the mile-a-minute pace within 5 miles, and by a maximum of 62½ on the short level bit after the rise at 1 in 440 between Tallington and Essendine. This rate fell to 58·4 on the 1 in 264 at the latter station, and to 46·3 at the 96th mile-post. On the next easier mile it increased to 50, falling to 48·9 on the rise at 1 in 178 at mile-post 97½. At mile-post 98 it was 50 again, but then fell away to 42·8 at Stoke Box, passed in 28 min. 18 sec. from Peterborough. At the 104th mile-post the speed was 69·2 miles an hour, with steam shut off and the brakes on, and we then approached Grantham rather slowly owing to relaying work in progress, and finally stopped in 120 min. 44 sec. or 114 min. net running time.

A few details of the running may prove interesting. Owing to the serious delay at New Southgate, only 49 miles were covered in the first hour, but in the second hour to the stop with the two delays at Peterborough and approaching Grantham, 56½ miles were covered. The 87¾ miles from Hatfield to Grantham required 88 min. 32 sec., and the 58½ miles from Hatfield to Peterborough 53 min. 37 sec., whilst the 60 miles from posts 15 to 75 were traversed in 54 min. 36 sec., an average of 65·9 miles an hour, and the excellent average of 50·3 miles an hour was made for the 23¾ miles from Peterborough to Stoke Box.

At Grantham the enterprise of the trip was by no

* No. I. appeared April 22nd.

means finished, for with a change of drivers and leaving to time, we ran the 14½ miles to Newark in 15 min. 36 sec., with a momentary speed of 80·3, and the running for the next 7 miles of level was of such an exhilarating character that we averaged over 75 miles per hour, so passing Crow Park, 22 miles, in 21 min. 16 sec. We then suffered our first delay in the shape of a reduction of speed to 30 miles an hour at the foot of the Tuxford bank. Nevertheless, the 134th mile-post was passed in 28 min. 55 sec., at 46·8 miles an hour, distance 28½ miles. Approaching Retford we were badly delayed by signal, yet, even so, required only 33 min. 58 sec. to clear. However, the speed was only 41 miles an hour after passing the station, increasing in 7 miles to 69·2 miles an hour; then on the rise to Piper's Wood summit it decreased to 56, increasing on the subsequent fall to 76·2 miles an hour. Then came serious signal delays, and no wonder, for, unchecked here, we should have been through Doncaster 4 min. ahead of schedule; in fact, as it was, in spite of the delays, we were through the station, though travelling dead slow, in 54 minutes, and the delays were such that 9 miles consumed no less than 14 min. 37 sec. instead of some 9 min. On the level before reaching Selby we got up to 68 miles an hour, and the 69 miles to the Abbey Town were covered in 75½ min., in spite of delays totalling 9 min. But our troubles were by no means over, for before reaching Riccall we were almost stopped and finally came to a stand for signals, after a further check, outside York Station, in exactly 96 min. This meant that the net time for the 82¾ miles to York was but 85 min., thus it would have been possible with an unchecked non-stop run to have covered the 188½ miles from London in 3 h. 16 min. with a 510-ton train, a saving of 14 min. on the schedule of "The Scarborough Flyer." The net time from Grantham to passing Doncaster was 47½ min.

I have noted many good trips behind "No. 2546," "Donovan," the best down trip being with 480 tons, with which Finsbury Park was passed in 6 min. 47 sec., Wood Green in 10 min., and New Barnet, 9 miles, in 15 min. 17 sec. The speed then fell to 40 miles an hour at Potter's Bar, passed in 20 min. 21 sec., but a rapid recovery followed, so that the next 5 miles to Hatfield were covered in exactly the same number of minutes. We did well thence to Hitchin by covering the 14½ miles in 13 min. 7 sec., so that we were through the Lavender Town in the quick time of 38 min. 28 sec. Thence to Huntingdon we ran in the quickest time I have recorded, attaining 84·9 miles an hour at Arlesey, and running to St. Neots with no lower speed than 66 miles an hour in 16 min. 40 sec. for the 20 miles from Hitchin, and the next 7¾ miles in 6 min. 10 sec., this good work enabling the Hitchin–Huntingdon length to be cleared in 21 min. 50 sec.—60 min. 18 sec. from London. Perhaps more exciting still was the time of 3 min. 6 sec. for the 3¼ miles from Huntingdon to Leys summit; but, unfortunately, an obstacle prevented the minimum speed being obtained. Holme, 69¼ miles, was passed in 69 min. 58 sec., and Yaxley, at reduced speed for signals, in 73 min. for the 72¼ miles. Peterborough could easily have been reached in 77¼ min., instead of the 83 min. allowed, but it was not to be, for, as a result of anticipating our booked time, we were further delayed by signal, being almost stopped at Fletton Box, and so occupied 81 min. 6 sec.

Another "racehorse" run of a similar nature was made with "Galtee More," "No. 2548," with the slightly lighter load of 465 tons, with which we were through Finsbury Park in 6¼ min., Wood Green in 10 min., and New Barnet in 15¼ min., with a minimum of 43·2, increasing to 45·4 at Potter's Bar, which was passed in 20 min. 18 sec. Hatfield was cleared in 25 min. 12 sec., and here 73·7 was recorded, and on the 1 in 200 to Welwyn we did not fall below 62¼ miles an hour, with 57·6 at Woolmer Green Box, this good climbing enabling us to cover the 14½ miles to Hitchin in 12 min. 53 sec., passing there in 38 min. 5 sec. At Arlesey the maximum was 81·1 miles an hour, and the minimum at St. Neots 63 miles an hour, the 26¾ miles to Huntingdon requiring 22 min. 46 sec., 58 miles being covered in the even hour from the start. At Leys the minimum was 53 miles an hour, the 3¼ miles from Huntingdon having taken 3 min. 13 sec. Near Holme the maximum was 73·7 and the 73rd mile-post was passed in 74 min. 6 sec., and we came slowly to the stop at Peterborough, after a slight signal check, in 78 min. 43 sec., over 4 min. ahead of schedule. It is worthy of note that 60 miles were covered in 53 min. 19 sec.

Of several performances with "No. 2555," built in the Railway Centenary year, and so fittingly named "Centenary," probably the most meritorious was with a train of 550 tons, with which we did well to pass Finsbury Park in 6 min. 50 sec., and Wood Green in 10¼ min. The climb to Potter's Bar was accomplished with no lower speed than 42 miles an hour. We passed that station in 20 min. 50 sec., and Hatfield in exactly 26 min., at a speed of 72¼ miles an hour. Ascending to Woolmer Green, the rate did not fall below 52·3 miles an hour, and Hitchin was cleared in 39 min. 32 sec. A rapid descent was then made, with a maximum speed of 84·9 miles an hour, the 20 miles from mile-post 30 to 50 occupying but 15¼ min., and 56¼ miles were covered in the hour from the start; the time for the racing stretch from Hitchin to Huntingdon being exactly 23 min. Here I would mention that the two previous trips enjoyed behind this steed gave times for this racing section of 22 min. 50 sec. and 22 min. 19 sec., with loads exceeding 500 tons, but on this occasion we were ahead of schedule at Huntingdon. On the Leys rise we did not go below 53 miles per hour until the final quarter, when the speed dropped to 46·3 miles per hour. We then suffered a slight signal check, after which we again ran finely, touching 76·2 miles an hour momentarily at Holme, and completing the final 14¼ miles in 14 min., so stopping at Peterborough in 79 min. 55 sec.

Then on the real tug-of-war section of the journey to Grantham we did excellently, passing Tallington in 11 min. 55 sec., after reaching 60 miles an hour. At Essendine the rate was still 60, and we were through there in 15 min. 48 sec., and tackled the rise at 1 in 200 to Little Bytham with a minimum of 44 miles an hour, increased to 47·8 before attacking the final ascent, up which speed dropped finally to 41·2 on passing the summit in 29 min. 53 sec., and we should have stopped at Grantham within the 36 min. allowed, but the signal was against us. Actually, however, we only exceeded time by ¼ min.

Continuing afresh, we passed Newark in 15 min. 27 sec., after a maximum of 76·2 miles an hour, and covered the 7¼ miles to Crow Park in 6 min. 24 sec., passing that station in 21 min. 50 sec. for the 22 miles, and reached the 134 mile-post in 29 min. 13 sec. for the 28½ miles, with no lower speed than 49·4 miles an hour. Retford was cleared in 33 min. 47 sec., and Scrooby, 40¼ miles, in 40 min. 5 sec. Then we reached 70·3 miles an hour on a level section, and I was anticipating a splendid "rush" at the Piper's Wood incline, when, alas, the brakes were applied for signals "on" at Bawtry; even so, we passed the station in 41 min. 54 sec. for the 42¼ miles. At Piper's Wood the speed had got up to 46·3, but we were again severely checked by signals; nevertheless, when we stopped at Doncaster the gross time was exactly 52¼ min., or 50 net, and we reached Doncaster but ¼ min. late, in spite of four signal delays, and more than 5 min. overspent at stations.

Some interesting comparisons may now be made. For example, the quickest non-stop schedule from King's Cross to Grantham is 114 min. by the 5.30 p.m. Newcastle express, and it is worthy of notice that "Centenary" reached the Lincolnshire town in 116 min. 11 sec. travelling time, including a stop and two signal delays. Further, the quickest non-stop booking from London to passing Doncaster is the 165 min. allowance of the down Pullman expresses, and the net time for this distance by "Centenary" with 550 tons only exceeded the Pullman allowance by ¼ min., despite the stops at Peterborough and Grantham; whereas the Pullman trains rarely exceed 350 tons. This, with the concluding details of performance, will demonstrate the margin of reserve possessed by the "Pacifics" for working the heaviest trains with express schedules probably better than any other illustration.

It has been stated on several occasions that Mr. Gresley had claimed that the "Pacifics" were capable of handling Scotch expresses up to 600 tons. The following performance on a Leeds and Bradford express of 595 tons weight gives ample justification for the claim. With this huge load, No. 4481, "St. Simon," got away from the London terminus with only one slip in the treacherous tunnel under the canal and cleared Finsbury Park in 8 min. 12 sec. and Wood Green in 11 min. 58 sec. at 48 miles an hour. Then came a serious delay near the 6th mile-post for the burrowing work which has been in progress for a considerable time, but the engine recovered from this in excellent style, and got up to 36 miles an hour at Potters Bar. Hatfield was passed at 69·2 miles an hour in 33 min. 25 sec., but owing to a Baldock train, hauled by a tank engine, not having apparently cleared Woolmer Green, we were slightly checked at Welwyn by signals, so that it required exceptionally fine work to clear Hitchin in 13 min. 48 sec. from Hatfield, the speed at Knebworth being 51·7, increasing to 68·2 before Stevenage, and not falling below 62½ on the short rise to that station. Through Hitchin the speed was 75, rising to 80·3 at Three Counties. Near St. Neots the rate fell to 60, but increased to 64·2 on the slight rise to the 52nd mile-post—exceptionally fine, this. Then with a maximum of 72½ at Offord, we were through Huntingdon in 23 min. 38 sec. from Hitchin. The Leys climb was achieved with a minimum of 50 miles an hour, which rate increased to 75 and was maintained for 1¼ miles, this latter length from Huntingdon to the dead stop at Peterborough requiring 18 min. 2 sec., and so we arrived in exactly 89 min., against a schedule of 83 min., but were certainly within our net time, as it was the 63½ miles from Potter's Bar had occupied 61 min. 12 sec. and the 60 miles from the 15th to 75th mile-posts 55 min. 44 sec. gross.

The next stage of the journey was more fortunate, in that no delays were experienced. We passed Tallington in 12 min. 32 sec. at 59·2 miles an hour, and Essendine in 16 min. 32 sec. at 56 miles an hour. Despite this comparatively slow speed, the 11¼ miles to the summit were climbed in 14 min. 25 sec. Before Little Bytham the speed had fallen to 50 miles an hour, but then it increased to 55½ on the 1 in 200, gradually receding to a minimum of 41 at the 96th mile-post, after which on the easier rise and short strips of level speed was regained up to 46·3 and to 47 on the first quarter at 1 in 178, falling back to 42·4 at the 99½ mile-post, from whence the remaining three-quarter miles consistently produced 41·2 miles an hour. So the summit was reached in 30 min. 57 sec., and shutting off steam nearing the 104th mile-post, we coasted through Grantham in 36 min. Then, when clear of the station, steam was re-applied and full advantage taken of the inviting descent to Newark, covering this 14½ miles in 12 min. 29 sec. with a top speed of 78·9. The next 7¼ miles were cleared in 6 min. 35 sec., and on the rise to Tuxford the minimum was 46·8. Thus the 18½ miles from Newark to Retford were covered in the fine time of 18 min. 33 sec. and the 33 miles from Grantham in 31 min. 2 sec., and 55½ were covered in the hour from the start. Excellent work considering the load and the long rise to Stoke Box. The final 17¼ miles to the stop absorbed 16 min. 59 sec. This included a maximum of 70·3 at Scrooby and a minimum of 53·5 at Piper's Wood, and again 70·3 before steam was shut off for the stop at Doncaster, which was accomplished in 84 min. 37 sec., nearly 3½ min. under schedule, so averaging 56½ miles an hour. The 50½ miles from Grantham were covered in 48 min. and the 36 miles from Newark in 35 min. 32 sec. Thus the gross time for the through journey, with one stop, was 173 min. 37 sec., or 167 min. net, and, if allowance be made for the Peterborough stop, within the "Pullman" schedule and a fitting climax to the down performance.

The "Pacifics" are equally masters of the situation on the up journey with all loads, as the following will bear witness. No. 4474, "Victor Wild," with the respectable load of 475 tons and an allowance of 85 min. from Peterborough to London, kept time despite a serious delay at New Southgate and signal checks at Holloway and Belle Isle Box, outside King's Cross tunnel, by attaining 62½ miles an hour on the level at Holme and ascending to Leys summit with a minimum of 45 miles an hour. After clearing Huntingdon, 17¼ miles, in 21 min. 33 sec., a splendid performance followed to Hitchin, with a maximum of 70·2 miles an hour before Offord and 72¼ after, which enabled us to pass St. Neots at 60. The next 20 miles, mostly uphill, were covered in 19 min. 12 sec., with a minimum of 52·3 on the 1 in 200 rise to Hitchin, increasing to 54·2 through the station, so the 26¾ miles from Huntingdon had required 25 min. 36 sec. But perhaps even better was to follow in that the 14½ miles to Hatfield were covered in 14 min. 55 sec. without the speed going below 47 miles an hour up the 1 in 200 to Stevenage. Thus the 58½ miles from the start had occupied 62 min. 4 sec. Potter's Bar was passed at 58·4 miles an hour in a further 4 min. 41 sec. for the 5 adverse miles and 68 miles had been covered in 70 min. 37 sec. when steam was shut off for the burrowing work in progress at New Southgate, but it was evident that King's Cross could have been reached in 79¾ min.

An undelayed run over the same length with No. 4475, "Flying Fox," and 465 tons, when Peterborough was left 5 min. late, gave the locomotive the opportunity to run in accordance with its name, and we were through Yaxley, 3¾ miles, in 6 min. 34 sec. and Holme, 7 miles, in 9¼ min. at 68 miles an hour. This fine burst of speed on the level helped us to ascend Leys with a minimum of 55½, and we were through Huntingdon in 19 min. 39 sec. St. Neots was passed at the exceptional rate of 68 miles an hour and the 20 miles to Hitchin in this instance occupied 18 min. 56 sec., so producing the excellent time of 25 min. 6 sec. for the Huntingdon-Hitchin section, giving a total of 44¾ min. for the 44½ miles from the start. The minimum at Stevenage was 45·4 miles an hour and Hatfield was passed in 60¼ min. and then the 5 miles to Potter's Bar were run in a like number of minutes. On the descent a maximum of 72¼ was recorded and Finsbury Park, 73¾ miles, was passed in 74 min. 25 sec., and we arrived at the terminus at correct time in 79 min. 10 sec., 77¼ min., platform end to end, and we had run in from Huntingdon and Hitchin, 58¾ and 32 miles, in 59 min. 31 sec. and 34 min. 25 sec. respectively.

With 470 tons, No. 2561, "Minoru," exceeded the Peterborough-London 85 min. schedule by 43 sec., owing to delays, which, however, amounted to 5¼ min. Within 4 miles from Peterborough we were travelling at 60 miles an hour and reached 66 at Holme, before ascending to Leys at a minimum of 53 miles an hour. This excellent progress resulted in a time of 20 min. 10 sec. to Huntingdon. Then came a maximum of 77¼ miles an hour, this good rate enabling St. Neots to be passed at 63·3, increasing to 72¼ on the level after Tempsford, and Hitchin was passed at 54·8 miles an hour in the splendid time of 24 min. 55 sec. from Huntingdon and 45 min. 5 sec. from Peterborough. We were now 4 min. ahead of schedule, for which we paid the penalty in the shape of adverse signals. However, we were left with 24½ min. to cover the final 22 miles, which, but for a subsequent delay, would easily have been accomplished. These three instances give the reader good examples of the average work performed on this section.

No. 4481, "St. Simon," left Doncaster 6 min. late with a modest 420 tons and passed Piper's Wood Box in exactly 10 min., the speed on the last quarter mile dropping from 50 to 43·6 miles an hour, probably owing to drastic "notching-up" and nothing higher than 65·2 was recorded to Retford, passed in 20 min. 23 sec. On the rise to Askham the excellent minimum of 51 miles an hour was noted, and then on the falling

gradient to Crow Park we reached 78·9 miles an hour. The ensuing 7¼ miles of level to Newark did not reduce this below 66, and that distance was traversed in 6¼ min., so that the 36 miles from the start were covered in 37 min. 12 sec. It will be noticed that this gives the good time of 16 min. 49 sec. for the 18¼ miles from Retford. Grantham was reached only 2¾ min. late in 53 min. 40 sec. with no lower rate than 48 miles an hour until passing the 107¼ mile-post, when the engine was distinctly eased.

Leaving Grantham 3 min. late, Stoke Box was reached in 10 min. 27 sec. at 40 miles an hour, and then a swift descent was made to Peterborough in 20¼ min., so that the full time for the 29¼ miles was 30 min. 57 sec., instead of the 34 min. allowed and the 6 min. late start from Doncaster converted into a punctual arrival. The maximum speed was 84·9 miles an hour and over 80 miles an hour had been averaged for 14 miles.

With the heavier load of 460 tons the same engine reached Piper's Wood in 9¾ min. with a minimum of 50 miles an hour, and attained 68 miles an hour after Scrooby, these higher rates bringing the time to Retford to 20 min. 4 sec. Excellent progress was again made to Askham summit, the minimum being the same as previously. Whilst on the descent we had attained 75 miles an hour, when we encountered signals adverse at Crow Park, followed by a more serious signal check near Newark, which caused us to pass through that station at a speed of only 50 miles an hour instead of 66, as previously, so taking 38 min. 2 sec., but we made an enterprising recovery on the gradients to Grantham, with a smarter finish, running the 14½ miles to the stop in 16 min. 9 sec. and not falling below 48·9 miles an hour until steam was shut off for the stop. The complete journey thus occupied 54 min. 11 sec., and again a late departure, in this instance 3 min., was turned into a punctual arrival, in spite of 1 min. delay by signals.

Leaving Grantham to time we made a better ascent to Stoke Box than on the previous trip in 9¾ min., attaining 42·8 miles an hour, but did not run as fast on the descent, requiring 21 min. 26 sec. for the 23¾ miles, with a maximum of 81·8, giving a full time of 31 min. 11 sec. As, however, we arrived at Peterborough 2 min. early, there was not the same need for hurry on this trip.

With an up Scotch express totalling 515 tons, No. 2546 "Donovan" turned a late departure from Grantham into a correct arrival by running the 105¼ miles in 116 min. 38 sec. We commenced by climbing to Stoke Box in 10 min. 13 sec., attaining 39·4 miles an hour. On the following descent the running was restrained, for we did not exceed 75 miles an hour, and that rate was only achieved for half a mile, the rate on this favourable down gradient being generally but 72½, but we ran smartly up to Peterborough platform before slackening through the station in 33¼ min. at 5 miles an hour instead of the 10 prescribed. Putting on steam again, we attained 64·2 before Holme, and then succeeded in ascending to Leys with a minimum of 48·9 miles an hour—excellent with this load—whilst such good progress was made to Hitchin that we covered the distance from Huntingdon in 26 min., so running the 44¼ miles from Peterborough in 46 min. 24 sec. Then, again, the speed did not fall below 48·9 on the more trying Stevenage gradient, and Hatfield was passed at 69·2 in 15 min. from Hitchin, with the splendid minimum of 53 miles an hour at Knebworth, and it would have been possible to have reached King's Cross in less than 114 min., as witness the following:—

Starting from Peterborough with 540 tons, "No. 2546" passed the 62nd mile-post at 45 miles an hour in 19½ min. for the 14¼ miles, and Huntingdon in 22¾ min. From there the running was superb with such a train, for with a rate of 66 miles an hour on the level at Tempsford, we covered the mostly adverse 26¾ miles to Hitchin in 26 min. 23 sec. On the ascent to Stevenage the speed had fallen to 45 miles an hour at the 30th mile-post, but continued unswerving at this rate to the summit. Hatfield was passed in exactly 65 min., leaving 20 min. for the final 17¼ miles. The 5 uphill miles to Potter's Bar were run in the splendid time of 4 min. 48 sec., with a minimum of 60, and we ran through Wood Green at 75 miles an hour, clearing Finsbury Park in 78 min. 36 sec. But at Belle Isle Box we were stopped by signal for 35 sec.; nevertheless we stopped in the terminus in 84 min. 25 sec., thus keeping the allowance of 85 min.; net time 83¼ min.

The above-mentioned heavy load was conveyed from Doncaster to Peterborough by No. 2543, "Melton," in exceptionally fine style, for Piper's Wood was cleared in 9 min. 10 sec., the minimum on that incline being 53 miles an hour, except for the last quarter, when it dropped to 48·3, from which on the down gradient it rapidly increased to 67, and Retford was made in the really splendid time of 19 min. 27 sec. The ascent to Askham was very fine, the speed not falling below 51·7 miles an hour, and a brisk descent produced 78·9 miles an hour as a maximum. The 134th mile-post had been passed in 24 min. 20 sec. for the 22 miles and Crow Park was cleared in 30 min. 22 sec. for the 28¼ miles. The next 7¼ miles of level to Newark were reeled off in 5 min. 52 sec., this rapid travelling bringing the train through that station in 36 min. 27 sec. for the 36 miles, and only 17 min. from Retford—a magnificent performance. On the rising gradients to Grantham the good work continued, so that we covered 41 miles in 41 min. 12 sec., and did not fall below 44½ on the 1 in 200 and had recovered to 47 when we encountered adverse signals, and were twice nearly stopped before arriving at Grantham, where we came to rest in 54 min. 49 sec., instead of the 57 min. allotted, and could have run the journey undelayed in 52¾ min.

Restarting from Grantham, the impediment to Stoke Box was attacked so well that the summit was passed in the splendid time of 9 min. 26 sec., the rate of progress having steadily risen to 43·2 miles an hour. A rapid descent was then made; however, owing to bad light, it was impossible to time many of the mile-posts with certainty, but a maximum higher than 83 miles an hour was achieved, for this rate was certainly averaged for 3¼ miles and 81·8 for over 7 miles, so Essendine—16¾ miles—was passed in 19 min. 8 sec., and Tallington—20¾ miles—in 22 min. The 79¼ mile-post—26 miles—was cleared in 25 min. 13 sec.; but then signal delays intervened, culminating in a dead stop of 29 sec. Even so, we stopped at Peterborough in 32 min. 35 sec., instead of the 34 min. allowed, whilst our net time was but 29¼ min. for the 29¼ miles. Thus we had run from Doncaster in 87 min. 26 sec., instead of 91 min., in spite of all delays. If these be allowed for, with 2 min. for the Grantham station stop, a net time of 80 min. for 79¼ miles must be credited to "Melton," and this with 540 tons!

The heaviest load I have actually had the pleasure of timing was one of 575 tons empty. The train was, however, very full, so must have totalled fully 615 tons behind the tender of No. 4479, "Robert the Devil." The train was a Scotch express allowed 41 min. for the 32¼ miles of practically level road from York to Doncaster. Escrick—7 miles—was passed in 11 min. 38 sec., and Selby at the reduced speed of 30 miles an hour for curves and swing-bridge in 18 min. 57 sec. for the 13¾ miles. Before the speed was reduced, it had reached 58·4 miles an hour, but after Selby we covered 8 miles before attaining 60 miles an hour, which was then consistently maintained and was sufficient to bring us to Doncaster in 39 min. 3 sec., effecting a saving of 2 min.

Getting away again, within 4 miles 50 miles an hour was attained, receding to 47·8 on the rise of 1 in 198 to Rossington, and at Piper's Wood, passed in 9 min. 42 sec., it had fallen to a minimum of 44 miles an hour. The speed increased to 64·2 at Ranskill and Retford was passed at 60 in 20 min. 43 sec. It was interesting to see how Askham would be tackled with this huge load, and it will be conceded that "Robert" did very well, for the rate did not fall below 53½ on the 1 in 178, nor 43·6 on the subsequent 1 in 200, enabling the 134th mile-post to be passed in 26 min. 3 sec. Immediately after passing Crow Park, on a short downhill length of 1 in 660, we attained the maximum for the trip of 73·7, and ran the 7½ miles thence to Newark in 6 min. 24 sec., passing Newark at 65 miles an hour in 38 min. 52 sec., the 18 min. 10 sec. from Retford being good in view of the load. Forty miles were covered in 42 min. 53 sec., but then the hill began to tell. At the 116th mile-post the rate was 62½ miles an hour, 2 miles further on it had fallen to 58·4, then for the 2 following miles on a gradient of 1 in 550 it remained at 56. On the 1 in 200 after Barkston the speed decreased to 45 miles an hour, the succeeding gradient of 1 in 440 through the tunnel brought the rate to 42; but, on emerging it increased to 42·8, and then increased to 45 near the 106th mile-post, when steam was shut off in preparation for the stop at Grantham, the 50½ miles being completed in 56 min. 10 sec., instead of the 58 min. scheduled, thus averaging practically 54 miles an hour over a road which, if not hard, certainly cannot be classed as easy.

From the foregoing it will be gathered that the "Pacifics" perform their duties in a most efficient manner, and in no case was any communication made with the locomotive men; the above details, therefore, represent actual everyday performance.

American Sea-Going Train-Ferry Steamers.

By E. E. R. TRATMAN.

No. IV. (*conclusion*).*

FROM the important train ferries of Lake Michigan we may turn now to some other and minor fresh-water and salt-water sea-going ferries.

MACKINAC MOTOR VEHICLE FERRY.

Although the steam ferry across the Straits of Mackinac is not for trains, it deserves notice here in connection with other Lake Michigan ferries, on account of its unusual character. With the extraordinarily rapid increase in the manufacture and use of motor vehicles, there has developed a great and growing amount of tourist and pleasure travel, for with such vehicles averaging one to every five or six persons, the population is largely "on wheels" during the summer. And this travel is by no means confined to the so-called leisured class. It includes the butcher, the baker, the candlestick maker, the butcher's delivery boy, the baker's man, the clerk, the workman, and the schoolboy, as well as the wealthier folk. To supplement this, there is a vast and increasing traffic with motor trucks of all kinds. As Lake Michigan intersects numerous highway routes there is a considerable business in the carriage of automobiles and trucks across the lake, and this traffic is handled partly by the various train ferries and partly by passenger steamers.

At the north end of the lake, however, the convergence of numerous highway tourist routes causes such an enormous amount of traffic of automobiles and trucks across the Straits of Mackinac that the highway department of the State of Michigan operates a line of ferry steamers for this service, as the railway train-ferry boats, already described, could not handle a fraction of the traffic. In fact, even with three boats in continuous service and carrying from fifty to eighty cars on each trip, the waiting cars stand in long queues—sometimes as many as a hundred in line—until their turns come. A fourth boat is to be added.

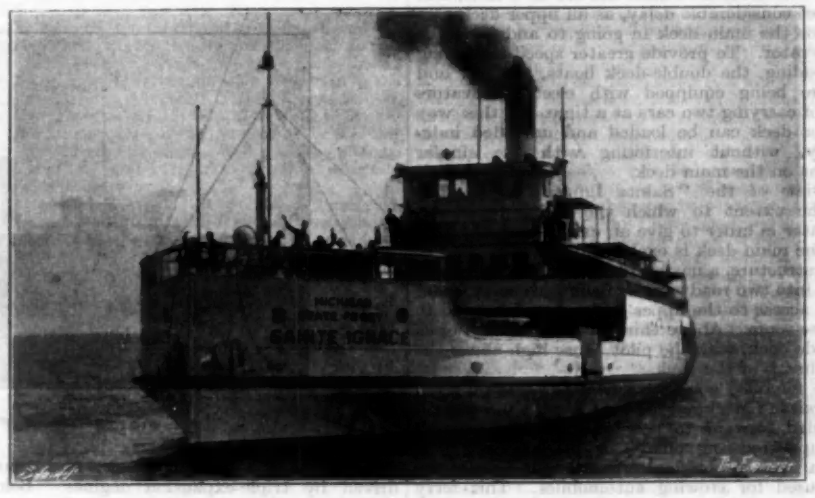


FIG. 25—AUTOMOBILE FERRY STEAMER "SAINTE IGNACE"

During the first season of this ferry, in 1923, the one steamer carried nearly 10,000 vehicles, while in 1925 two larger boats carried about 60,000 during the navigation season of eight to nine months. In 1930 the three boats carried the enormous traffic of 125,243 vehicles and 222,502 passengers, the last figure including the pedestrians, who are few in comparison with the occupants of the cars. In winter the traffic is light, and is handled by the train-ferry steamers already described, although it is now proposed to keep one of the motor vehicle boats in service as long as the ice permits. The severe ice conditions in the Straits have been explained in a foregoing article. The navigation season averages from middle of April to middle of December.

Two of the present boats are 210ft. long and 45ft. beam, with a loaded draught of 10ft. Above the water line the hull is flared out in order to give great width of deck. These two boats, the "Sainte Ignace"—Fig. 25—and the "Mackinaw City," have twin screws and two engines of 275 H.P. each. Their sea speed with full load is about 9 miles per hour. The new and larger "Straits of Mackinac"—Fig. 26—has a single screw, but its one engine is of 1200 H.P., and its sea speed is 12 miles an hour. The fourth boat is to be about 250ft. long and 60ft. beam, and will be designed as an ice-breaker for service during a part of the winter.

From dock to dock the distance is about 9 miles, and the trip takes some 50 to 60 minutes. Since these boats have a short route and do not traverse the open lake, the car deck is not entirely enclosed,

* No. III. appeared April 22nd.

although the after part is roofed by the promenade deck, while the forward well deck is protected by a short but high forecastle. The boats moor alongside a pier at Mackinaw City and a wharf at Saint Ignace. There are two wide gangways in the bulwarks on each side, for the forward and after decks respectively. They are used simultaneously in loading and unloading at busy times; or loading can begin at one gangway while the last cars are being unloaded at the other gangway. The cars run on and off by their own power, and take positions as directed by the deck officers, who get them packed closely in order to carry as many cars as possible during the busy season.

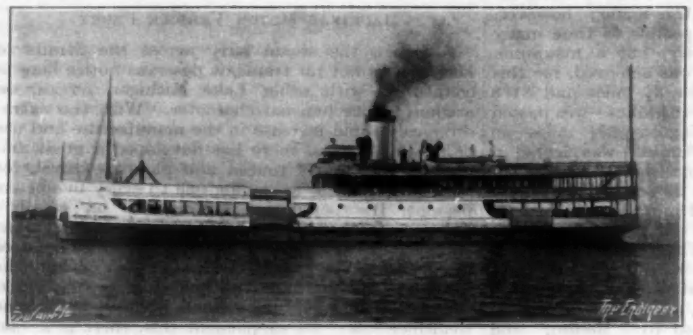


Fig. 26—Automobile Ferry Steamer "Straits of Mackinac"

On two of the boats, motor vehicles are also carried on an upper deck, built between the forecastle and the promenade deck, in order to increase the capacity. This construction is shown in Fig. 26. A lift on the foredeck handles one car at a time, and this causes considerable delay, as all upper deck cars must cross the main deck in going to and from the lift or elevator. To provide greater speed in loading and unloading, the double-deck boats, the pier and wharf are being equipped with electric elevators capable of carrying two cars at a time. In this way the upper deck can be loaded and unloaded independently, without interfering with the similar operations on the main deck.

The view of the "Sainte Ignace"—Fig. 25—shows the extent to which the hull is flared out above water in order to give an exceptional width of deck. The main deck is exclusively for vehicles. In the superstructure, a narrow central enclosure divides the deck into two roadways and contains companionways for access to the upper deck and saloon and to the engine-room. Above this upper deck is an open promenade deck, with the pilot house high above the forward break of the deck.

In the modified construction of the largest boat, the "Straits of Mackinac"—Fig. 26—the upper deck is extended forward to the forecastle, its framing being supported on pillars or stanchions. This extension over the original forward well deck is the portion used for stowing automobiles. This ferry service is operated by the State Highway Department of Michigan.

Other Sea-going Train Ferries.

Although there are several other American deep-water or sea-going train ferries, none of them approach the importance or handle the traffic of the Lake Michigan services, the reason being that the lake lies in a strategic position intersecting various direct railway routes between eastern and central sections of the country and the vast and growing region of the North-West. On the lower lakes there is one train ferry across Lake Erie and another across Lake Ontario. The Florida East Coast Railway operates a train ferry between the United States and Cuba, and there is an independent American–Cuba service. The Canadian National Railways operate a train ferry to connect with its railway lines on Prince Edward's Island.

American-Canadian Train Ferries.—The one train ferry on Lake Erie is that of the Marquette and Bessemer Line, running between Conneaut, in the United States, and Port Stanley, Canada, in connection with the Bessemer and Lake Erie Railroad and the Canadian railways. There is only one steamer, with a capacity of thirty cars, but no passengers or motor vehicles are carried. In 1930 it carried nearly 48,000 cars, mainly with coal, coke, and steel, as the railway serves the great steel and iron manufacturing district around Pittsburgh. The crossing, 60 miles, is made in about five hours. Ice is troublesome in winter and the boat does not run when the ice is heavy.

On Lake Ontario the one train ferry is operated between Charlotte, U.S.A., and Coburg, Canada, in connection with the Buffalo, Rochester, and Pittsburgh Railway and the Canadian National Railway. The distance is 58 miles from dock to dock, and is made in about five hours. The freight carried is mainly coal and general merchandise, but on this line passengers and automobiles are accommodated. There are two steamers, both built in Canada. Ice troubles on this lake are not severe.

These boats and the one on Lake Erie are of the same general type as those on Lake Michigan, with high freeboard, stern entrance, and twin screws driven by triple-expansion engines. Below Lake Ontario, a train ferry is operated across the St. Lawrence River, and though this is not of the same type as the others mentioned, it is worth noting, since it is of an unusual character. It runs between Ogdensburg, U.S.A., and Prescott, Canada, in connection with the New York Central Railroad and the Canadian Pacific Railway. A steamer has been used for it service, but in 1930 this was replaced by a steel barge with an oil-electric tug lashed alongside. This barge is 290ft. long, 45ft. beam and 12ft. 6in. deep, with four tracks accommodating eighteen cars in all. An interesting feature is that the tug is controlled electrically from the pilot house of the barge, which is mounted on a lofty bridge spanning the train deck.

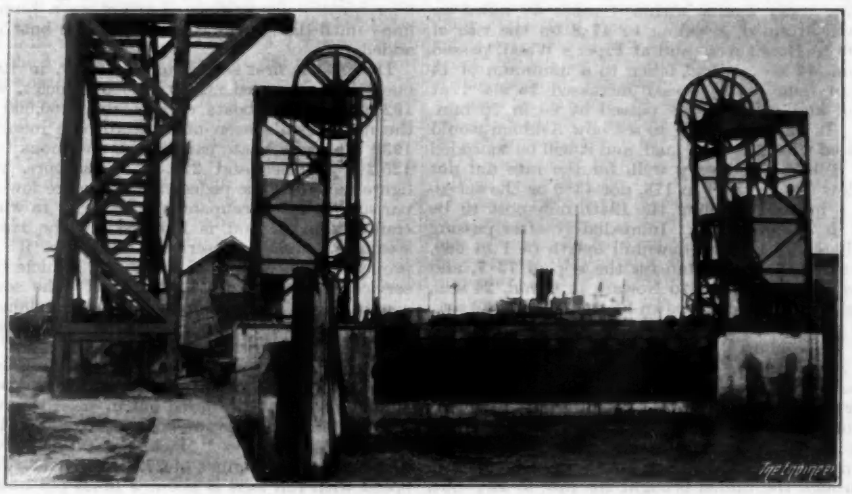


Fig. 27—Train Ferry Landing Apron at Key West

Florida-Cuba Train Ferry.—By means of a series of concrete arch viaducts across open-sea channels between a chain of coral islands and reefs, the Florida East Coast Railway has extended its line 125 miles beyond the tip of the Florida mainland to the small island of Key West, where its terminus is established. From that point the railway operates both fast passenger steamers and train-ferry steamers to Havana, Cuba. The distance is 90 nautical miles, and the trip is made in about 7½ hours by the train-ferry steamers.

The landings at Key West and Havana differ from those at the Lake Michigan ports—already described—in the manner of supporting the outboard end of the landing apron or transfer bridge. Instead of being suspended from counterbalanced rocking beams by hangers or steel bars, it is suspended by cables attached to the corners of the apron. These cables pass over large grooved pulleys on steel towers, as shown in Fig. 27, and then down to concrete counterweights, which slide in guides. Hand-operated gears adjust the height of the apron to meet the deck of the boat and lock the cables and counterweights in position.

For this Cuban service there are three boats, one of which—the "Estrada Palma"—is illustrated in Fig. 28. They are 350ft. long, 60ft. beam, and 18ft. 6in. deep below the train deck, with a loaded draught of 15ft. They have twin-screws and triple expansion engines of 2700 H.P. Each boat can carry twenty-six or twenty-eight freight cars. No passenger carriages are handled, and the train ferry has no accommodations for passengers, as these are conveyed on special fast steamers. This railway now plans a train-ferry service of about 700 miles between New Orleans and Havana, touching at Key West.

New Orleans and Cuba Train Ferry.—Already in operation is this service of the Oversea Railway Company, which was established between New Orleans and Havana in 1929, and which differs from all other train ferries in the construction and car capacity of the steamer, the length of voyage, and the way in which the cars are handled. The distance is about 600 miles, which is covered in about fifty-two hours. To unload and load at each port occupies ten hours, and the one boat makes one round trip each week. The purpose of this service is not to operate through-cars over the Cuban railway system, but to avoid the damage and delay of transferring goods from railway car to steamer and again from steamer to car.

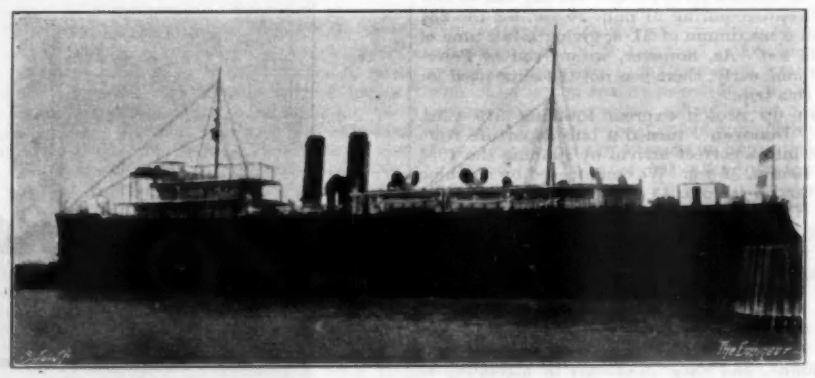


Fig. 28—Train Ferry Steamer "Estrada Palma"

The train-ferry steamer—the "Seatrain," built in England by Swan, Hunter and Wigham Richardson—is 427ft. long, and 62ft. 3in. beam, with the distinctive feature of carrying cars on four decks and handling them through deck hatches by powerful cantilever cranes. The deadweight carrying capacity is 10,500 tons on a draught of 25ft. 9in. The single screw is driven by a triple-expansion engine of 3500 H.P., having cylinders 28in., 46in. and 77in. in diameter and 54in. stroke. Steam is supplied by three oil-fired Scotch boilers 16ft. diameter and 12ft. long, carrying 180 lb. pressure.

There are four lines of rails on each of the four decks, giving accommodation for a maximum of ninety-five cars—twenty-six on the tank top in the hold, twenty-six on the lower deck, thirty on the main deck, and sixteen on the upper deck. The shorter tracks on this last deck, which is not covered, are reserved for empty cars. A hatchway 50ft. long extends across the full width of deck and serves all the tracks.

On the landing pier is a steel tower 105ft. high, to the berth side of which is pivoted a boom or rectangular frame that can be lowered to a horizontal position extending over the ship when moored with its hatchway opposite the tower. A trolley with cable hoist or winch of 105 tons lifting capacity travels on rails laid across the tower and along the boom, giving a travel of 90ft. A freight car is pushed into the base of the tower, where it stands on a movable steel platform or cradle and is secured in position. The travelling hoist or trolley raises the cradle, runs it out over the steamer and over the track designated, and then lowers it to the required level, the cradle rails then registering with those of the deck.

A power winch with cable hauls the car into position on the deck, where it is secured by clamps

and jacks. A car for delivery ashore is run on the cradle and hoisted and landed in the same way. The cradles serving the lower decks, of course, pass through the hatches and are locked to form parts of the decks when at sea, the last car loaded remaining on the cradle. Larger cradles for the main deck form the hatch covers, and these also carry cars when at sea if there is a full cargo. A special cradle for the tracks on the open upper deck is made long enough to serve as a bridge between the forward and after portions of that deck. This vessel was described in THE ENGINEER of November 30th, 1928. It is adapted only for long voyages, and the operation would be much too slow for the quick transit required on the Lake lines.

Canadian National Railway Train Ferry.—To connect its mainland system with its lines on Prince Edward Island, the Canadian National Railways operate a train ferry across the Northumberland Strait, between Cape Tormentine and Borden, a distance of about 10 miles. Heavy ice interferes with the service during the winter. A new boat, the "Charlottetown," built in Canada by the Davis Shipbuilding Company, and put in service in 1931, is 324ft. long, 59ft. beam, 25ft. deep below the train deck, with a loaded draught of 19ft. and a cargo or carrying capacity of 1380 tons.

Three tracks on the main deck can accommodate sixteen railway cars. While the Lake Michigan train-ferry steamers carry only such motor vehicles as can find room on the train deck, and, hence carry only a few as a rule, the "Charlottetown" is arranged to carry forty cars on the upper deck. Landing gangways enable these vehicles to run on and off the vessel under their own power. Another special feature is a vertically sliding gate to close the open stern of the train deck when at sea. This gate is at the end or break of the upper deck and high side plating, and takes the place of the hinged stern gate or bulkhead across the extreme end of the main deck, as used on the other boats described.

The bow or forefoot is reversed to receive a bow screw, which is used not only in breaking up and displacing the ice, but also to assist in manœuvring. The twin screws for propulsion and the bow screw are driven by three triple-expansion engines, having cylinders 20in., 41in. and 66in. diameter and 36in. stroke, aggregating about 7500 H.P. Eight Scotch boilers, carrying 180 lb. pressure, are fired with oil, for which there is a tank of 450 tons capacity The cabins can seat 250 passengers. As the trip is short, there is only limited berth accommodation, but to provide for the contingency of delay by the boat being held in the ice, there is a large supply of folding cots.

CONCLUSION.

Whatever may be the arguments for and against the desirability of train ferries, there is no doubt as to their practicability. The cost, also, for boats and port facilities, would be but a fraction of the cost of the tunnel, such as the English Channel Tunnel, about which there has been such protracted controversy. The main and deciding question is the traffic conditions, and the desirability and advantage of through train service between the island and the continent.

The essential practicability of such a project is proved by the long and successful operation of the several American deep-water, sea-going lines—exclusive of river train ferries, to say nothing of the Harwich-Zeebrugge lines, the German and Danish lines, and the lines connecting the islands of the Empire of Japan.

But, taking all these lines into consideration, there is no doubt that the most extensive train-ferry service in the world is that on Lake Michigan, in the United States, where about twenty large modern boats are in continual operation on nine routes with ten ports, and are operated by half a dozen railroads.

Suction Gas and Tractors.

(By a Correspondent in Southern Rhodesia.)

For several years it has been considered in South and East Africa and in Rhodesia that agriculture will make no real progress till there has been evolved a really efficient unit providing cheap power for tillage and belt work. While prices were good and left a considerable margin of profit a large number of tractors running on power paraffin were bought in the British Possessions south of the Equator, but these being almost without exception made in America—the natural home of petroleum—economy in fuel is not one of their chief points. It stands to reason that paraffin in a country such as Rhodesia can never be an economically possible fuel, since the railage alone on a case—8¼ Imperial gallons—of power paraffin from Beira lies between 4s. and 6s., according to distance, and the average price of paraffin landed on a Rhodesian farm is generally taken to be 2s. or a little more, 2 gallons at least being required to plough an acre of land.

It is safe to say that at least 50 per cent. of Rhodesian farm tractors, and probably a greater proportion in the Union, are at present lying idle, even though it has been found possible to run several makes of tractors on a mixture of crude oil and petrol working out at 1s. 3d. a gallon on the farm.

Crude oil tractors have been tried with success on some farms, but while these are economical and efficient in use, the initial price, which would in many cases represent more than the initial cost of the farm, and is nearly double that of paraffin tractors, would render their general adoption impossible. In the case of steam, also, the same objections hold good, though steam tractors are in use on a few of the larger farms in the Colony.

Suction gas would appear to be the only possible solution of the problem, and in this it would appear that a great opportunity for the British manufacturer is going begging.

It would seem that the only branch of farm machinery in which the products of American enterprise are not already firmly established is that of suction gas, a form of power which would have unlimited possibilities in countries such as Rhodesia, where the cost of petroleum fuels is exorbitant, and in most parts of which wood may be had for the cutting. Indeed, it may be affirmed that cheap power for farm work and transport is absolutely essential for the white farmer if he is not in the course of a few years to be driven off the land by native competition; while there are at present large areas of potentially highly productive land which are lying idle and will remain so until the tsetse fly is conquered—at present an unlikely possibility—or cheap power is available to replace draught animals.

The Government of Southern Rhodesia has been watching the development of suction gas plants for some years past, but until lately the tests to which they have subjected the various apparatus offered for trial have been more or less disappointing. The latest of these tests, however, has given extremely encouraging results, both with a tractor and a light lorry, and the plant concerned is now being manufactured in Salisbury, Southern Rhodesia, by the "High Speed" Gas (Rhodesia), Ltd. The inventor of this plant is at present in France, where, at the request of the French Government, he is demonstrating his plant to them. The French, there being no petroleum properties under their control, are, naturally, very interested in any plant of this kind.

The drawback to all suction gas attachments that have reached this country, or of which the writer has obtained particulars from other countries, would appear to be that neither is the attachment made for the tractor nor is the tractor made for the attachment. It seems likely, however, that a suitable tractor and gas plant will soon make their appearance either in France or America.

Practically 100 per cent. of the tractors in Rhodesia are constructed to burn paraffin, those using petrol only being prohibitive in their fuel bill. These tractors necessarily have to have the inlet manifold so arranged that the exhaust gases heat and vaporise the paraffin, and as this arrangement with suction gas does not allow the cylinders to draw a full charge of gas, considerable alteration in the induction system has to be made. The compression, too, has to be increased to a ratio of about 7 : 1 to secure proper ignition of the gas and the greatest efficiency, this being at present effected by affixing a plate to the pistons, which, in view of the extra weight and therefore wear and tear, is surely undesirable.

The ignition also presents certain problems, since with gas the spark must be advanced much further than is necessary in the case of paraffin, and yet must be capable of sufficient retardation to allow of easy starting on petrol, the backfire of a tractor in starting being dangerous to the operator on the crank handle, as the writer can testify.

Most of the smaller tractors in Rhodesia are rated at 10–20 H.P., that is to say, 10 H.P. on the draw-bar and 20 H.P. on the belt, while most of the larger develop 14 or 15 on the draw-bar and from 27 to 30 on the belt. From this it will be seen that under average conditions a tractor requires half its total power to move itself. But since most of the areas possible for white settlement in Rhodesia and Central Africa are limited, for reasons of health and climate, to an altitude of 4000ft. or over, it follows that the total power of these tractors is reduced by 16 per cent. or even, in the higher areas, by 24 per cent., which means a reduction in draw-bar pull of approximately 30 per cent. to 50 per cent.—a very serious loss. And if, as at present, a further loss of a few per cent. occurs with the use of suction gas, it puts the use of this fuel out of the question for the lighter tractors, except for belt work and the very lightest field work; while even the bigger tractors are seriously handicapped if conditions are at all heavy.

The recent test conducted under the auspices of the Agricultural Department of Southern Rhodesia furnishes a good example of this, even though the tests were considerably more successful than any previously made by them. An American tractor fitted with a "High Speed" gas producer was used, the induction system being altered to avoid preheating the gas, and the compression being increased to 7 : 1 by means of aluminium plates on the pistons.

With a tractor of the same make the writer is able to plough an acre in an hour to an average depth of 7in. approximately, in soil perhaps a little lighter than that on which the test was made. But with suction gas, at an altitude of about 800ft. more than that of the writer's farm—4200ft.—and presumably with the agent's mechanics at hand to ensure best results, this area was reduced to 0·6 acre per hour to a depth of 6in., a reduction of over 40 per cent. Furthermore, the tractor stalled in a piece of extra heavy ground, as it was already in low gear.

It will be understood that, although the cost of fuel—charcoal—and lubricant is very greatly reduced, even with this low performance, a reduction of 40 per cent. in the work done in a given time, greatly increases the per-acre cost for labour, if, as is generally desirable, a white man is employed to drive. This increase would, however, be negligible if a native were driving. If the tractor were owner driven, as is the case on many farms, including that of the writer, it is very probable that the extra time could not be spared from other farm duties.

To quote from the report of the recent tests, previously mentioned, "It may not be generally known that fruitless inquiries have been made of several English firms on behalf of this Government for tractors specially designed for suction gas, as it was realised that when an efficient producer was available it could not be used to the best advantage until such a tractor was available." Is not this an opportunity for the English manufacturer to assert himself in the South and East African markets?

It is quite certain that power farming will never make any headway till such a tractor is offering, for, as previously mentioned, at least 50 per cent. of Rhodesian tractors are idle, and of the remainder 50 per cent. are used for rush work only. The expense of running them has forced many farmers to return to oxen, although ox ploughing is nearly as expensive for labour as would be the whole cost of ploughing by suction gas. Since 100 oxen divided into six spans with four spare are about equal as far as farm work goes to one large tractor, ploughing an acre per hour, and since these oxen need about 800 acres of grazing, it is apparent what a great benefit it would be to the farmer to be able to sell off eighty of them and buy a tractor, which is independent of droughts and disease.

It is notable that of the several makes of English tractors which have at one time or another been on the Rhodesian market none appear to have been suited to the conditions, with the possible exception of the last and newest, which, owing to its appearance just before the slump in commodity prices, has not yet had a fair chance. But even this tractor embodies several features which have made the other makes of British tractors unpopular and which appear to have spoilt the market for English cars in the Empire.

Briefly summarised, they are, as far as tractors are concerned, these: small bore, long stroke, high-speed engine. Though these features may be suitable for, and account for the development of, the engines of those aeroplanes which now carry the mails once a week each way over the writer's farm, in comparatively dustless air, the conditions which they have to undergo there are very dissimilar to those obtaining on the ground underneath. Here, in the writer's opinion, the American practice of large bore, comparatively short stroke, and low-speed engine is more suitable, giving, as it does, less wear and vibration and consequently longer life.

Here are a few more points which should be given consideration in the design of a tractor for use in hot countries. Perhaps one of the most important is that of cooling. Working at a temperature of 120 deg. to 130 deg. in the sun, as it usually does in the field, the life of a tractor in Rhodesia is, to use the words of one owner, "one long boil," and since with gas there is no great need for a really hot engine, the engine temperature could with advantage be reduced considerably below that usual for paraffin engines.

It must also be borne in mind that field work for a tractor in hard sun-baked lands, with stumps, roots, and stones dotted here and there, is a series of bumps and jars more or less severe. At least one type of gas producer of which the writer has knowledge, though quite effective for a tractor on belt work or in soft, smooth ground in the field, would not work at all on land at all bumpy or rough.

The question of the utilisation of maize cobs—*i.e.*, the core on which the grain grows—is also worthy of consideration. These can be charred in a kiln, but the ideal would be to use them whole, as they are just the right size—about an inch thick and up to about 9in. long, or a little more in a heavy crop. They contain a good percentage of volatile hydrocarbons, although some of these, being of a tarry nature, would have to be removed by a suitable scrubber. At present, in default of any means by which they may at a reasonable cost be converted into humus, these cobs are simply burnt; but since an acre of maize produces enough cobs to plough several acres of land, the advantage of using a fuel all ready to hand, of the right size, and costing nothing, is evident. The cobs, when charred in a kiln, have been tried by the makers of the "High Speed" producer and found satisfactory, but when charred there is very little weight in maize cobs, and the loss in charring is considerable.

What is wanted would appear to be a well-built tractor of about 40 H.P., with large bore, comparatively short stroke, and a low-speed engine, with two or, better, three gears forward and one reverse, and equipped with a gas producer which does not generate enough heat to incommode the operator, and with a track able to clear the rows of the main crops of Central and South Africa, in the case of maize 36in. to 42in. or, better still, with an adjustable track such as in the case of a recent model of a Canadian tractor, and with a short wheel base enabling a fairly sharp turn, in a radius of about 12ft. And, above all, at a reasonable price.

If English manufacturers could supply a tractor on these lines they would be assured of a demand from all the Colonies in South and Central Africa at least, and probably in Australia, where a considerble amount of experiment in suction gas has recently taken place, and possibly in Canada as well.

And if, employing such a tractor as the key to the market, they would then build a line of implements to suit, it is probable that they would have taken a very large step towards capturing, as all Britons would like to see them and help them do, the market for agricultural implements in the Empire.

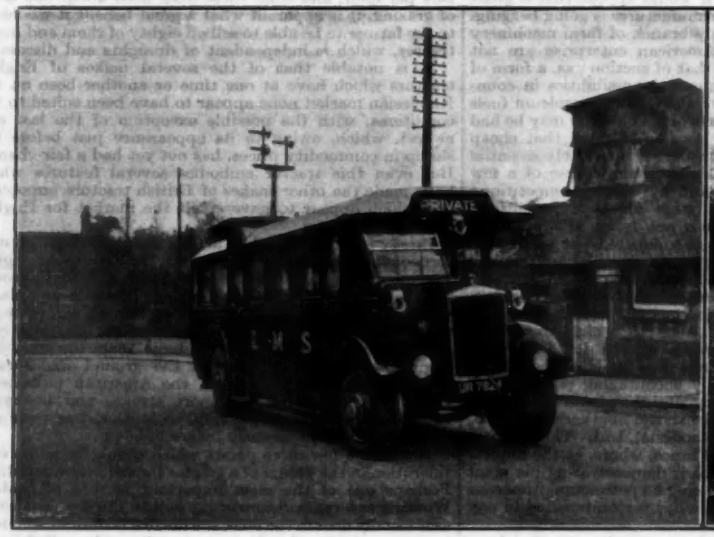
It may be said that there is no country in which the development of English agricultural machinery is more sympathetically watched than in Rhodesia, or where an English tractor would be given a fairer trial.

AMERICAN PERMANENT WAY DEVELOPMENTS.

IN close relation with the increasing weight of rails in main line construction on American railways—with rails weighing from 130 lb. to 152 lb. per yard—is the gradual introduction of a new system of track maintenance or maintenance-of-way. In the old and still almost universal system, this work is done by section gangs, each with a foreman or ganger, and under a roadmaster or permanent way inspector, who may have jurisdiction over 100 to 300 miles, according to conditions of track and traffic. Each section gang handles practically all the work on its section, except where re-ballasting or long stretches of rail renewal are handled by special forces. In the new system practically all the track maintenance on a roadmaster's division is handled by one or two special gangs, provided with work trains and well equipped with power tools and devices. The sections may then be lengthened and the section gangs reduced to two or three men, who have simply to carry on the daily inspection and minor repairs. It is claimed that this system is much more economical, especially as modern heavy track will not require so much attention when once put in good condition.

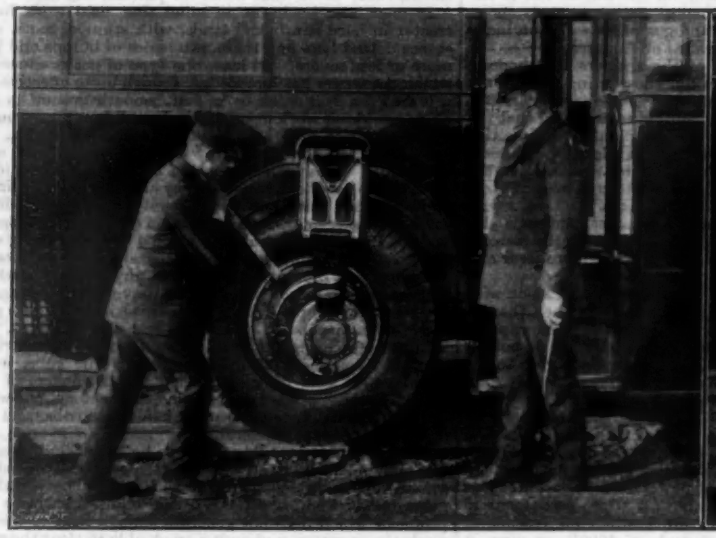
LONDON, MIDLAND AND SCOTTISH RAILWAY COMPANY'S ROAD-RAIL VEHICLE

KARRIER MOTORS, LTD., HUDDERSFIELD, ENGINEERS



ROAD-RAILER ON THE ROAD

ROAD-RAILER ON THE RAILS



LIFTING ROAD WHEEL TO RAIL POSITION

ROAD WHEEL DOWN IN ROAD POSITION

The L.M.S.—Karrier Road-Rail Vehicle.

On Saturday last, April 23rd, the L.M.S. Railway Company's road-rail vehicle, illustrated herewith, was introduced into regular public service. From now onwards until further notice it will operate a daily service in both directions on week-days only between the L.M.S. Welcome Hotel, Stratford-on-Avon, and Blisworth, at which station it will connect with the express trains to and from London. Between the hotel and Stratford-on-Avon Station, the vehicle is licensed as an omnibus, while after being changed from road to rail, or *vice versâ*, at Stratford-on-Avon Station, it replaces an ordinary steam train. The present scheduled service is an afternoon and evening one, the road-rail vehicle leaving the Stratford-on-Avon Welcome Hotel at 4.10 p.m., with a 10 minutes' stop at the Stratford-on-Avon Station, and departing therefrom at 4.30 p.m., so as to connect at Blisworth with the 5.32 train, arriving at Euston at 7 p.m. On the return journey the vehicle waits at Blisworth and connects with the 4.35 p.m. train from London, departing from Blisworth at 6 p.m. and arriving at Stratford-on-Avon Station at 7.10 p.m., where 5 minutes is allowed for the change from rail to road, the Welcome Hotel being reached at 7.25 p.m.

Our illustrations show the road-rail vehicle and indicate the manner in which the road wheels are suspended above the rail wheels or lowered to be concentric with them when running on the road. The chassis, with its wheel-lifting and lowering gear, has been specially designed by Karrier Motors, Ltd., of Karrier Works, Huddersfield, to the requirements of Mr. J. Shearman, the road motor engineer of the London, Midland and Scottish Railway Company. The body was supplied by Cravens' Railway Carriage and Wagon Company, Ltd., of Sheffield. As will be seen from the illustrations, the general appearance of the vehicle differs very little from that of an ordinary road vehicle, but it embodies special features apart from the wheel-changing device. Thus, if required for towing, both buffers and draw gear can be fitted at either end, with the necessary lamps for rail travelling. The entrances to the coach on either side are so arranged that by the use of a sliding floor, which, when operating as an omnibus is mechanically stowed, the passenger entrances can be conveniently made from the road or, alternatively, from the railway station platform. Sanding gear for use on the rails is provided, and is controlled from the driver's cab.

The principal particulars of the vehicle are given in the following table:—

Horse-power of engine, six-cylinder	65–110 (R.A.C. rating 37·2)
Chassis wheel base	17ft. 1in.
Road wheel track	6ft. 3½in.
Size of tires—Front	36in. by 6in.
Rear	42in. by 9in.
Rail gauge	4ft. 8½in.
Top gear ratio, road	7 to 1
Top gear ratio, rail	4·2 to 1
Maximum speed, road	60 m.p.h.
Maximum speed, rail	75 m.p.h.
Petrol consumption, road	8 m.p.gal.
Petrol consumption, rail	16 m.p.gal.
Load capacity	26 passengers or 3 tons net
Overall length	26ft.
Overall width	7ft. 5½in.
Overall height, road	9ft. 9½in.
Overall height, rail	9ft. 6½in.
Floor to roof height	6ft. 4½in.
Unladen weight complete	7 tons 2 cwt. 2 qr.

From the particulars mentioned above, it will be gathered that while normal gear ratios are provided for road service, it has been found desirable for rail service to provide some means of reducing the engine revolutions with relation to the vehicle speed. For this reason an overspeed gear-box of suitable ratio is fitted, which permits a low engine speed with high fuel economy, while maintaining a high rail speed.

The principal interest centres, of course, on the means adopted for changing from rail to road, and *vice versâ*. In practice, this operation is very simply carried out. Flanged wheels are fitted to the axles and on the outside of the rail wheels, which are of the Lang laminated wood disc pattern, they are attached to pneumatically tired road wheels. These are carried by an excentric device supported on an extension of the axle shaft. By means of a cam arrangement, the road wheels, after the driving pins have been withdrawn, can be slewed round and locked in a position such that their axis is vertically above that of the rail wheels by about 6in. In that position they are, as shown by our illustration, locked to the chassis frame, so that the lower edge of the tire is about 6in. above the flange of the rail wheel, giving ample clearance. When running on the road, the road wheels are locked concentrically to the rail wheels, which, being of smaller diameter, are clear of the road. For road to rail transference the vehicle is driven on to the rails at a point at which the level of the road has been made up to the top of the rails—generally by sleepers and ballast. When the wheels, which can be conveniently guided by side plates, are directly over the lines, the vehicle is driven forward a few yards until it reaches a point where the made-up road tapers off, allowing the rail wheels to come gradually into contact with the rails and take the weight of the vehicle off the road wheels. The road wheels are then lifted and secured in their stationary position for rail service. The device now fitted, which we shall describe in further detail in a later article, is a modification of the dual excentric arrangement with which Karrier Motors, Ltd., experimented two years ago and fitted to the vehicle when in January, 1931, the official L.M.S. Railway trials were made at Redbourn on the branch line between Harpenden and Hemel Hempsted.

The new coaling plant of the Southern Railway at Dover, to which reference was made on page 237 of our issue of February 26th, was used for the first time on April 19th, when a cargo of 2450 tons of Kent coal was shipped.

On the occasion of the meeting of the Institution of Electrical Engineers, held on April 21st, when Dr. W. E. Sumpner delivered the Kelvin Lecture on "The Work of Oliver Heaviside," the Faraday Medal was presented to Sir Oliver Lodge. It is awarded by the Council not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering, or for conspicuous service rendered to the advancement of electrical science, without restriction or as regards nationality, country of residence, or membership of the Institution. The first medal was awarded to Oliver Heaviside in 1921, and Lodge is therefore the eleventh recipient. In thanking the Institution, Sir Oliver said that he supposed it would be the last medal he would receive. He and the Institution had practically grown up together. He remembered hearing Graham Bell describe the first telephone, and he had not forgotten the enthusiasm and scepticism it aroused. There were sceptics about everything. The word "sceptic" probably meant one who looks into a thing and he had no objection to that kind of scepticism. The day of electricity was only beginning, and what it would ultimately do, he did not know.

Railway and Road Matters.

HERRIN, on December 11th last, we mentioned that the whole of the track at Borough Market Junction, near London Bridge, where the two Charing Cross lines join the four lines between London Bridge and Cannon-street, was to be renewed in manganese steel. This work was begun on Sunday, April 24th, and will take three week-ends to complete.

IN pre-war and the earlier post-war years, there was a fine service of trains between King's Cross and Cambridge which made the journey in eighty minutes. An important feature in the London and North-Eastern train services from May 2nd is a revival of the use of this route. There will be five expresses in each direction, which will be provided with buffet cars and the third-class compartments will have arm-rests.

ANOTHER important change in the London and North-Eastern train services to be introduced on May 2nd is that the breakfast car train, i.e., the 7.50 a.m. from Leeds to King's Cross, will cover the 105½ miles from Grantham to London in 100 minutes, which calls for an average speed of 63·3 m.p.h. This will not only save eleven minutes in the running time, but secure for this train the honour of being the fastest non-stop run, of over 100 miles, in Europe.

THE Ministry of Transport railway statistics for January have recently been issued as a Stationery Office publication, price 2s. 7½d., post free. They show that, compared with the corresponding month of 1931, there was a decrease of 7·9 per cent. in the number of passenger journeys, and of 11·2 per cent. in the receipts from passengers. Passenger train mileage was reduced by 0·7 per cent. The tonnage of freight traffic was 2·5 per cent. less, and the receipts fell by 8·5 per cent., and the freight train mileage was brought down by 4·6 per cent. The average train load decreased from 127 to 122½ tons, but the ton-miles per hour, i.e., the speed of movement, was raised from 430 to 437.

THE Transport Committee of the House of Commons was addressed by Sir Ralph Wedgood on the evening of April 20th. The railway companies' case was put very fairly, and the speaker admitted that it might be founded on an incorrect appreciation of the facts, or it might be overstated, but those points would be cleared up by the Salter Committee. In concluding, Sir Ralph observed that the railways asked that the whole matter should now be reviewed and that the whole basis of road transport, as the latest comer, should be re-examined to make sure that each main section of it was paying its costs and that it was being worked under conditions appropriate to its healthy development as a public service.

To the list, given on page 264 of THE ENGINEER of March 4th, of engineers who have been made general managers of British railways, may now be added an Irish example. Mr. C. E. Riley, who succeeded Mr. M. F. Keogh, as general manager of the Great Southern Railways in May, 1928, has now retired and Mr. W. H. Morton, the chief mechanical engineer, has been promoted to the vacant position. Mr. Morton served his apprenticeship with Kitson and Co. and subsequently remained with that firm until 1900, when he went to the Midland Great Western of Ireland, where he eventually became the locomotive superintendent in 1915. On the incorporation of that railway into the Great Southern group in 1924, Mr. Morton was made deputy chief mechanical engineer, and in April, 1929, succeeded Mr. Bazin as chief mechanical engineer.

UNTIL the Ministry of Transport came into being in 1919, railways were under the administration of the Board of Trade, and, even to-day, some of the older railway officers may be heard referring, by force of habit, to "Board of Trade inspections," and "Board of Trade inquiries." Justification may, therefore, be found for our mention herein of the recent legislation for an indemnity for the present and some immediate Past-Presidents of the Board of Trade against penalties they are alleged to have laid themselves open to for not seeking re-election, under the Succession to the Crown Act of 1707, on being appointed to that office. Such re-election was made unnecessary by an Act passed in 1826, but when it was amended in 1909 that provision was accidentally not repeated. A point of historical interest is that, up to the Railway Clauses' Act, 1845, all references in railway Acts to that Department mentioned it as "the Lords of the Committee of Her Majesty's Privy Council appointed for trade and foreign plantations."

IT speaks highly for the excellent way in which British railway engineers maintain their rolling stock that since the Bullhouse, Penistone, disaster of July 16th, 1884—nearly fifty years ago—there has been only one accident, due to a broken axle, in which passengers lost their lives. The latter case, moreover, occurred exactly thirty years ago. It was the Hackney Downs derailment of April 25th, 1902, when four passengers were killed. Unfortunate as that accident was, it brought considerable credit on this particular point to the Great Eastern Railway. The axle was one of a consignment of one hundred which had been bought, in December, 1900, at an exceptionally high price on account of their superior quality. The railway company got Mr. William Dean, the then Locomotive, Carriage and Wagon Superintendent of the Great Western, to give evidence before Colonel von Donop at the Board of Trade inquiry. He said that he could only speculate as to the original cause of the breakage. It most probably arose from some small particle of the furnace lining falling into the steel while in a molten state, and it would not be noticeable in any subsequent process of the manufacture of the axle. Flaws of that kind were occasionally found to exist, and, generally, their development was rapid. He saw nothing in the character of the fracture which would indicate that there was external evidence of the existence of the flaw and that, again, was no uncommon experience. The axle in question was made of a material known as homogeneous iron, which he would call a very mild form of steel. It was, in his opinion, the very best form of material for axles that he knew of.

Notes and Memoranda.

IT is expected that the new bridge across Burrard Inlet, Vancouver, which has cost 3,000,000 dollars, will be opened early this summer.

RAIL lengths of 197ft. are being tried on the German Federal Railway. They are formed of two 98½ft. lengths welded together, to reduce joint trouble.

WHILE our imports of motor cars and chassis during the first quarter of this year were less than one-fifth of the number imported during the first quarter of 1931, exports were 43 per cent. higher than a year ago and 22 per cent. higher than in the last quarter of 1931.

CAST iron roads have been ordered by the City of Birmingham, the Borough Councils of Rochdale and Burnley, and the Great Western Railway Company. These contracts have been placed following the experience gained on four different sections of road working in London, where the traffic conditions are unduly heavy. The cast iron sections, of which the road is built up, are mass produced by the Stanton Ironworks Company, Ltd.

THE Research Council of Alberta reports a discovery which will cheapen the extraction of oil or bitumen from McMurray tar sands. For some years research has been carried on into methods of separating oil from the bituminous sands which are a very extensive resource in the Athabaska Valley, Northern Alberta. The investigators, Dr. K. A. Clark and Dr. D. S. Pasternack, now report that practically 100 per cent. of the oil or bitumen can be recovered using a solution of soda ash to neutralise the acid in the sand.

SELENIUM, which is now being produced on a commercial scale by the Ontario Refining Company, finds its present chief market in the glass industry, where it is used as a coloriser and for neutralising other colours. It is also used in the pottery industry for the same purpose. In the manufacture of rubber products, it serves as a vulcanising and accelerating agent, and because of its reputed properties of increasing the resistance to abrasion of rubber up to as much as 80 per cent., it may have a large potential market in this industry. One of the most important potential uses is in the production of selenium cells for television transmission and reception. The normal price of selenium during 1931 was 1·80 to 2 dollars a pound. It is generally sold either in the form of an amorphous powder or as small rods and buttons.

SHOULD it be possible to make profitable use of bagasse as a by-product of the sugar milling industry, Dr. F. Maxwell has suggested that it might be worth while to reduce the amount of sugar extracted and increase the amount of bagasse available. Taking, for example, a typical large Cuban mill in which seven or eight milling units extract about 95 per cent. of the available sugar, requiring about 2500 horse-power, the first three units of the train will extract some 85 per cent. of the sugar with an expenditure of about 1000 horse-power. The units necessary to extract the final 10 per cent. require 1500 horse-power. He has therefore suggested that if these, or some of these, were closed down to give a lower but more economical extraction, the bagasse saved—otherwise used as fuel to drive the mills—would be rendered available for other purposes.

THE bulk of the carbon dioxide used by the Dry Ice Corporation, of America, which has a manufacturing capacity of over 30 tons of "dry ice" per day, is obtained by the combustion of coke, but at Yonkers there is a plant producing 10 tons per day and using the carbon dioxide from molasses fermentation. The purified gas is compressed in three stages, 75 lb., 300 lb., and 1100 lb. After the first compression the gas is further purified by treatment with permanganate solution to remove traces of impurities, and is liquefied at 1100 lb. pressure by cooling it to 70 deg. Fah. in a condensing coil. The liquid is permitted to expand through a nozzle into a double wall tank with a filter cloth top, and in this the "snow" is formed, the unchanged gas escaping through the cloth and being returned to the compressors. The "snow" is tamped in moulds and compressed at 500 lb. per square inch into a solid block.

THE result of processing Sydney coal in the Illingworth test plant at Pontypridd, South Wales, may, according to a report of the Canadian Department of Mines, be said to have (1) confirmed the claims of the company for their process, and (2) shown that Sydney coal is suitable for this method of carbonisation. The fuel produced is hard and dense, and preliminary tests indicate that it will be entirely suitable for Canadian conditions of house heating. The success of a plant of this description depends, as far as Canada is concerned, on certain economic considerations, such as location of plant, cost of plant, conversion costs, and markets. In the opinion of the writers the greatest possibility of success with this process would be its installation at a mine, where the raw material is at its lowest cost, provided that the available markets for the product were within reasonable freight hauls. Such conditions appear to exist in Nova Scotia.

A VISCOSITY-TEMPERATURE chart has recently been adopted as a tentative standard by unanimous action of Committee E-10 on Standards, of the American Society for Testing Materials. It was prepared by A.S.T.M. Committee D-2 on Petroleum Products and Lubricants, which has been working on the problem for some time. The Committee's efforts have resulted in a chart which will be of distinct service to the petroleum, motor car, and other industries. The new tentative standard incorporates the best features of all the previous charts used, particularly the generally used charts of Larson and MacCoull. The chart is printed in a large size, 16¼in. by 21¼in., covering a temperature range from −30 deg. to 450 deg. Fah., and a viscosity range of 37 to 100,000,000 Saybolt Universal seconds. It is printed on tough, thin paper that permits handling without damage, and it may be ammonia printed or blue-printed with excellent results. These charts are available at the Society's headquarters, 1315, Spruce-street, Philadelphia, Pa., at 25 cents per single copy, 1·50 dollars per pad of twenty-five, or 5 dollars for four pads.

Miscellanea.

THE Cunard liner "Carmania" has been taken to Blyth to be broken up.

THE new destroyer leader "Kempenfelt" has successfully completed her official trials.

NINE new whaling vessels have just been launched on the Tees from the yards of Smith's Dock Company.

ACCORDING to *Allgemeine Thüringensche Landeszeitung*, there are as many as 200 German firms desirous of starting factories in England.

THE new bridge across the Cauvery at Sivasamudram, in India, has recently been opened. It is about a mile in length, has forty-two spans, is 18ft. wide, and has occupied about three years in its construction.

EVERYTHING movable on a farm near Worksop, Notts., was recently conveyed by the London and North-Eastern Railway to Ulceby, Lincolnshire, in one train. It comprised sixty-three wagons, twenty-one trucks, and three horse-boxes.

THE Rotterdam-Lloyd cargo liner "Tosari," of 7050 tons, has recently had her turbine propelling machinery removed and replaced by a single-acting two-stroke oil engine of 5000 B.H.P. The engine runs at 95 revolutions per minute and gives the vessel a speed of 14 knots.

A VEIN of witherite—native barium carbonate—is now being worked in the Morrison North Pit, County Durham, owned by the Helmside and South Moor Collieries Company, and there is a prospect that a reasonable output may be secured within a few years, such as will justify development.

A TURBO-GENERATOR with a capacity of 18,000 kW has recently been put in commission by the Public Service Electric and Gas Company, of New Jersey. It works with steam at a pressure of 730 lb. per square inch and a temperature of 860 deg. Fah. The speed of the turbine is 3600 r.p.m.

A TOUR of Egypt and the Sudan extending to 5000 miles has just been completed by four different motor cars of British make. They included a Riley, a Morris, a Crossley, and a Commer. The route included the crossing of the Nubian Mountains and occupied three months. All the cars successfully withstood the test.

ALTHOUGH the Shanghai Telephone Company's contracts for the conversion of the Shanghai telephones to automatic operation provided for completion in two years, the entire work has been competed in less than twenty months, according to a report from Mr. Frank Gill, vice-president of the Shanghai Telephone Company.

THE total number of motor vehicles in Great Britain on February 29th, excluding tramcars and trade licences, was approximately 1,662,000, compared with 1,573,000 in the corresponding period of 1931. Mechanically propelled road vehicles registered for the first time in February totalled 16,095, compared with 15,757 in February, 1931.

THE last section of tunnel No. 2 of the Catskill aqueduct system, which supplies New York City with water, was holed through on March 30th. The tunnel is 20·2 miles long, and is in rock at depths ranging from 200ft. to 700ft. below the surface. It is to be concrete lined, with an internal diameter of 17ft. The estimated carrying capacity is 700 m.g.d.

THE first plant in Germany for the production of petrol from natural gases was, says the *Chemical Trade Journal*, recently started up by the Gewerkschaft Elwerath in Hannover. The plant was constructed by the "Bamag" Company, and operates by the active carbon process of the Carbo-Union (Bayer process). The plant is designed for the daily production of 4000 kilos. of petrol.

THE new B.B.C. West Regional transmitting station in North Somerset is to be equipped with four sets of Crossley six-cylinder vertical Diesel engines for dynamo driving. These are similar to the Crossley installation just completed at the new Scottish Regional station at Falkirk. Broadcasting House, London, will also install in the near future a Crossley five-cylinder vertical engine driving a 100-kW alternator.

IT has already been announced that the Institution of Electrical Engineers' Summer Meeting will take place in Yorkshire from May 30th to June 3rd, the headquarters being at Harrogate. The meeting will include visits to Leeds, Huddersfield, Dewsbury, Sheffield, and York. Members of the Institution who desire to take part, but have not yet sent in their applications should do so without delay. The railway companies in Great Britain have agreed to supply members of the party with railway tickets to and from Harrogate at two-thirds the ordinary fare.

A LARGE and well-equipped laboratory for research on cements and concrete products is being constructed at the Building Research Station, near Watford, of the Department of Scientific and Industrial Research. By means of air conditioning plant installed in the basement the temperature in all the rooms in the new building will be maintained at 64 deg. Fah., while the relative humidity will be maintained at 65 per cent., except in the chemical laboratories on the first floor. The facilities for research available in the new laboratory which, as regards control of atmospheric conditions, is in advance of anything of the kind in other countries, should enable valuable and reliable data to be obtained.

CLAIMS have been put forward for an American device for heating seed beds by electricity controlled by thermostats and so bringing the spring forward several weeks. This idea, a correspondent reminds us, has been practically carried out in Britain for at least 3½ years, but development has, he says, been delayed by the charges for electric current. Electrically heated seed beds would use current almost exclusively throughout the night, the very time when power stations need an outlet for current. The supply authorities in this country, our correspondent asserts, still fail to see the many fields in which current can be effectively sold at specially low rates, with the result that they are only doing a tithe of the business that might be done.

YARROW BOILERS AT HELSINGFORS POWER STATION, FINLAND

(*For description see page* 483.)

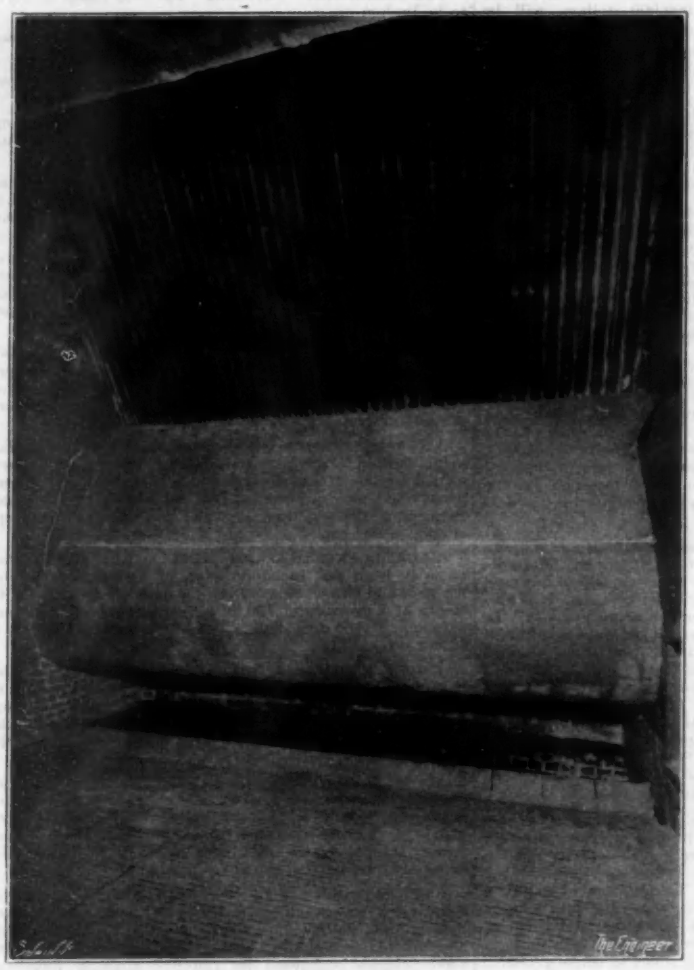


FIG. 1—BACK END OF COMBUSTION CHAMBER

FIG. 2—FRONT END OF COMBUSTION CHAMBER

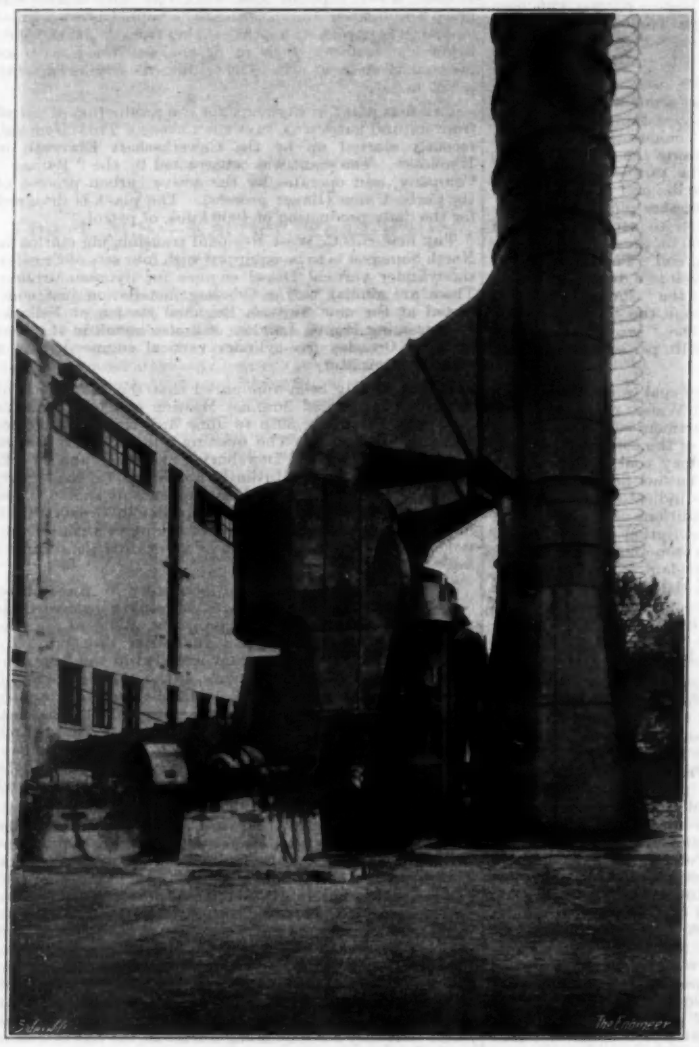


FIG. 3—FLUE GAS CLEANING PLANT AND FANS

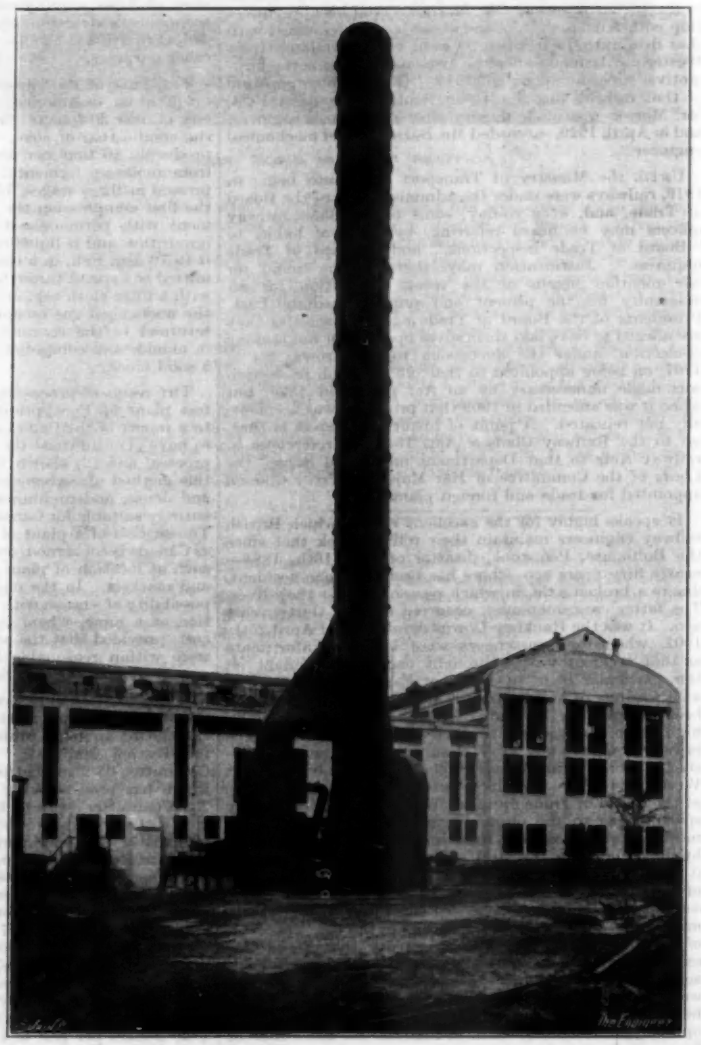


FIG. 4—CHIMNEY, FLUE GAS CLEANING PLANT AND POWER HOUSE

The Engineer

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SIXTEEN-PAGE SUPPLEMENT—"THE METALLURGIST."

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The Metallurgist.

THE APRIL NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

OLIVER HEAVISIDE.

THE story of Oliver Heaviside's work so ably told in the twenty-third Kelvin Lecture, delivered by Dr. W. E. Sumpner before the Institution of Electrical Engineers last week, dealt with the outstanding achievements of that remarkable man. No pioneer in the field of electrical communication was less adequately rewarded for his services or lived a more extraordinary life. With the time available, Dr. Sumpner had to confine himself almost entirely to what Heaviside did, but it is really essential, if it is desired to try to discover why his efforts led to so little personal gain, to know something of the man himself. Like many brilliant physicists, he was not commercial, nor was he orthodox. Disheartened by seeing his ideas exploited by others, he severed himself from society. For years he lived the life of a recluse, and towards the end was entirely alone. He is said to have purchased supplies of food and other necessities through the kind voluntary services of a constable attached to the Devon County police. He never married or took very much interest in anything beyond work. Had he been differently constituted, and had he protected his ideas, as he easily might have done, possibly he would have received a better reward, although it is not unusual for a genius to leave little behind in the form of money. His peculiarities, which seem to have constituted his principal stumbling block, have often been jokingly referred to at meetings of the Institution of Electrical Engineers. When, in 1921, the Institution awarded him the first Faraday Medal, Mr. J. S. Highfield, who was then President, journeyed to Torquay to present it to him, for, as someone explained, Heaviside had his own ideas about medals, and it was of little use asking him to come to London to receive it. After his death, when technical newspaper men began to collect material for obituary notices, they found it was impossible to learn anything about a great part of his life. The best biography that has been written is probably that which appears in Rollo Appleyard's "Pioneers of Electrical Communication," although the author does not by any means claim that he has provided an unbroken record of Heaviside's career. Positive evidence about his education, he says, is entirely lacking. There is a legend that, at an early age, he was taught by his mother, and it is certain that from 1876 he subjected himself to strenuous training. Although it has often been said that he at one time held a post with the Great Northern Telegraphy Company, of Newcastle, definite proof has not been established. Difficult as it was to get information together, Appleyard succeeded in portraying the characteristics of the man. Just as Heaviside attached little importance to medals, so did he place small value on photographs of engineers. Concerning a contemporary photograph of a group of members of the I.E.E., he is said to have remarked: "Giants at the back, pigmies at the front. I gave it, framed and glazed too, to a Newton Abbot furniture dealer for nothing, along with an old kitchen table."

Stories such as this in Appleyard's book serve to show that Heaviside was far from conventional and that he resented anything bordering on self advertisement. But his work was of great value. His discoveries and teachings provided the impetus that was needed to lift electrical communication practice from the rut of contentment with moderate achievement and to render possible the establishment of a speech and signalling network embracing the world. His main work may be said to have consisted in the simplification of Maxwell's theory, the production of improved mathematical methods for use with it, and the design of a transmission line or cable which would convey long-distance electrical signals perfectly at high speeds. As every electrical communication engineer knows, Heaviside advocated increasing the self-induction of the line, an idea utterly opposed to the prevailing notions of the time. His analysis was so obscure, Dr. Sumpner explained, that had it not been for his powers of making his views clear and simple, he doubted if the loading coil would have been invented during his lifetime. In dealing with cable problems, he laboured under many disadvantages. He had to deal with mathematical problems so new and so difficult that no existing form of analysis was suitable. He therefore evolved an experimental process which found no favour with mathematicians. In 1892 he summed up his work on Maxwell's theory in a paper printed by the Royal Society. That was the most important and ambitious paper he ever wrote. But, said Dr. Sumpner, it was safe to assert that no one completely understood it. The mathematics, though having a strong Heaviside flavour, were orthodox; but the assumptions underlying them involved numerous physical conceptions, for the most part outside the range of experimental evidence, and so little recognised that however they were expressed in words they could readily be misunderstood. In summarising Heaviside's activities, Dr. Sumpner said that if mathematicians spent on his work as much as one per cent. of the time they devoted to that of Fourier, they would find many things that would astonish them. Heaviside, in his opinion, was a second Fourier, and his reputation would increase with time. To-day, his name is familiar to many people who, had it not been for broadcasting, might never have heard it. It was originally supposed that wireless communication over great distances would be impracticable because the waves would shoot off into space instead of bending round the earth. Marconi's experiments showed that that assumption was wrong, and it was not until Heaviside suggested that the reflecting properties of an ionised layer in the upper atmosphere might be responsible for the bending of the waves that the matter began to be understood. Although many have disputed the theory, and although some may still be sceptical, the investigations of Professor Appleton and others have removed nearly all doubt about the correctness of Heaviside's assumption.

When Dr. Sumpner's address is printed in the *Journal* of the Institution of Electrical Engineers, it will, perhaps, lead many to investigate Heaviside's work more thoroughly than they have done before. Here, of course, little more has been attempted than to call attention to the address, which displays a great knowledge and appreciation of what Heaviside did. Those who have the time and inclination to study the writings to which Dr. Sumpner alluded, may find that the range they cover is much wider than they supposed. The work on the cable problem, while directed to one end, involved surmounting one difficulty after another, and did a great deal more than lead to the theory of the loading coil. It showed that ordinary telegraphy is but a special form of directed wave telegraphy and that Heaviside was really a pioneer in the field of radio communication. His work was in advance of his time. Less brilliant people than he often failed to grasp his arguments and were sometimes inclined to regard him as a nuisance rather than a help. But to-day the value of his achievements is widely recognised, and Dr. Sumpner is probably right in assuming that his reputation will increase as the years roll by.

Film Lubrication of Journals.

FILM lubrication differs from ordinary lubrication by reason of the fact that the lubricant moves forward with a steady flow across the bearing. In the case of journal bearings, it enters between the journal and the brass at one side, and, following the direction of rotation of the shaft, is delivered at the other. The film is in the form of a curved wedge wrapped round a segment of the journal, the entering side being the thicker. To permit the ready formation of this shape, the radius of the brass may be greater than the radius of the journal. Loading the journal excentrically also assists in the formation of the film. There is little or nothing new in all this. Osborne Reynolds, seeking a solution of the phenomenon of oil pressure in a bearing, accidentally discovered by Beauchamp Tower, studied the question in the 'eighties, and in 1886 defined the condition as "hydro-dynamical." The practical sequel to his investigations was the invention of the thrust bearings of Michell and Kingsbury, in both of which hinged pads replace the ordinary fixed bearing surfaces. These pads are at liberty to tilt slightly, so that they automatically place themselves in that attitude which the formation of the hydro-dynamical film requires. Michell subsequently produced a journal bearing composed of pads. The advantage secured by these practical applications of film lubrication is that much greater loads than those tolerable with ordinary, or, as it is called, "greasy" lubrication, are possible, because, as Beauchamp Tower put it, the wear takes place in the oil and not on the metal. The film-lubricated thrust bearing has come into extended use for many purposes, and in all important ships has replaced the old "horse-shoe" thrust. The film-lubricated journal bearing does not enjoy similar popularity.

Recognising the merits of film lubrication for cylindrical bearings, investigators, both in this country and abroad, have devoted careful study to it. Amongst these workers are Mr. R. O. Boswall, who for upwards of fifteen years has been making experiments, and Mr. J. C. Brierley, who, with Mr. Boswall, presented a paper on the subject to the Institution of Mechanical Engineers in London on Friday last. All their experiments were made with plain brasses on plain journals, some of the former being "bedded" to the journal and some being of slightly larger radius—"clearance brasses." The apparatus employed permitted the brasses to adjust themselves to the journal, so that the necessary attitude for film lubrication could be automatically assumed. In the case of the clearance brasses, there was little difficulty in securing this condition, but with bedded brasses it was only reached when both the inlet and outlet edges were chamfered. In both cases it was found that the formation of the hydro-dynamical film was encouraged by loading the bearing excentrically. As a result of this long series of experiments, the authors have shown the conditions necessary for film lubrication, and have developed its mathematics. They have thereby presented engineers with material for the scientific design of cylindrical bearings. Can their conclusions be applied in practice? Can bearings be so designed that the advantages of film lubrication will be secured with certainty? Will designers, with the information before them, venture to employ bearings with much higher unit pressures than those commonly in use, in full confidence that wear will never take place as long as a few conditions are observed? That is the practical issue of a scientific research. As far as it has gone, the investigation is wholly physical; the problem now before engineers is to turn it to useful account. Can that be done? It must be admitted that as far as plain bearings are concerned, the outlook is not very encouraging. Even with a bearing specifically designed, film lubrication is not established at once. A period of ordinary or greasy lubrication precedes the formation of the film, and that period, brief as it is, must be passed through without damage.

Hence, unit pressures higher than those which experience has shown to be safe would hardly be welcomed. Again, the employment of a cap in a film-lubricated bearing is beset with difficulties. Unnecessary as it may be in certain cases, few engineers would care to run the risk of omitting the cap. Or, again, as Dr. Stoney pointed out when Messrs. Boswall and Brierley's paper was read in Manchester a few weeks ago, the film lubricated bearing of the clearance type would not damp out shaft vibration, as the ordinary complete bearing does. Excentric loading presents another difficulty, particularly in the case of machines required to run in both directions. Whether such practical difficulties as these can be overcome or not remains to be seen, but it is significant that although the principles of film lubrication have been known for many years, the successful application of them has made but little progress, save in bearings of the Michell type.

Whatever may be the outcome of the many years of scientific study which have been devoted to this matter, it seems certain that the employment of film lubrication in cylindrical bearings will be limited to relatively few special cases. Its employment would appear to be out of question for rapidly varying and reciprocating loads, and its chief field of utility would consequently be found in turbines, dynamos and motors, and similar machines, in which the speed, the load, and the direction of the load are usually constant for prolonged periods. The possibility of applying the principle to the axles of vehicles raises an interesting question. Assuming that the effect of gravity on the lubricant is negligible, it would seem that the ordinary axle bearing of railway rolling stock gives the conditions necessary for film lubrication. There is no cap, the "brass" extends over only a portion of the circumference, and there is no reason why the edges of the "brass" should not be freely chamfered. In road vehicles the advantages of the ball and roller bearing, with their low starting resistance, are too great to be challenged. The most hopeful field of application is presented by the turbine, and it will be of the greatest interest to see if other inventors following in the footsteps of Monsieur Brillié and Mr. Robb, can devise forms of "brasses" which will ensure the development of the hydro-dynamical film and yet present sufficient surface to carry the load safely during starting and other conditions when film lubrication cannot be counted upon. That seems to us to be a crucial problem connected with the design of such bearings.

The Engineers' German Circle.

The first lecture course of the Engineers' German Circle came to a successful conclusion on Monday, April 18th, when close upon one hundred and fifty members and guests assembled in the large hall of the Institution of Mechanical Engineers to hear Professor Dr. Conrad Matschoss lecture on "Monuments of Technical Science in Germany." It was fitting that, as at the inaugural meeting on February 1st, representatives of the Institution of Mechanical Engineers, the Verein deutscher Ingenieure, and the German Embassy were present. Dr. Conrad Matschoss, Director of the Verein deutscher Ingenieure, is a world authority on the history of engineering science, and he was thoroughly at home when describing some of the treasures of Germany's technical and industrial museums and relics of past engineering progress which are now preserved in their original positions, where many of them are still in productive service. He made a plea for the more careful preservation in all countries of typical examples of outstanding engineering merit, such as old windmills, water wheels, tilt hammers, horse gins, beam engines, and manual industrial processes, such as would enable present-day students to follow the history of engineering progress in the same manner as is possible with other sciences and arts. It was also intensely interesting to hear briefly the views of Dr. Matschoss on the work of the engineer in relation to the present industrial crisis, and the place of the machine, in present-day and future progress. These questions have recently been the subject of vigorous discussions in Europe and America, and passing reference was made by Dr. Matschoss to the views held by Stodola, Spengler, Schumacher, Ortega and Nägel, as well as those of various American authorities. At the close of his address Dr. Matschoss paid a warm tribute to the pioneer work done by the Science Museum at South Kensington, instancing the quite recent Children's Gallery and other exhibits arranged by Sir Henry Lyons, and the earlier work done by Mr. H. W. Dickinson, who is now continuing his historical research as the secretary of the Newcomen Society.

In all there have been, in the short period of a little over three months, four technical and one social meeting of the newly founded Circle. The subjects dealt with have embraced various developments on widely differing engineering activities, including high-speed oil engines, machine tools and modern steam boilers. The papers have been of a high order, and in some instances have dealt with entirely new technical developments. It is our intention to present in one of our future issues a translation of one of them. Opportunities for talking German have not been neglected, and both before and after the meetings free conversation has taken place and has been encouraged by the hospitality shown to the Circle and its members by the Institution of Mechanical Engineers and the Anglo-German Club. During the summer it is the intention of the Circle to arrange one or more technical visits, and the second lecture course will begin in October. The number of members has rapidly risen to nearly 150, and it shows signs of still increasing. We congratulate the Committee, the chairman (Dr. S. G. Davies), and the secretary (Mr. H. P. Spratt of the Science Museum) on the success of the movement, which has been reflected in Berlin by the recent founding in that city of an Engineers' English Circle. One of the principal aims of these Circles is to bring into being friendly relations between the engineers of both countries, and we feel sure that Professor Dr. Conrad Matschoss at Ingenieurhaus, Berlin, will be very glad to hear from engineers who, when visiting that city, are prepared to read an original paper in English or repeat there a paper already given elsewhere.

Literature.

Artificial Earthing for Electrical Installations. By T. C. Gilbert. London: Ernest Benn, Ltd. Price 9s.

The title of this book calls for explanation. Artificial earthing is a term introduced by the originators of a system of protection against leakage potentials to differentiate their systems from solid earthing, and although it is not a very appropriate term, it is adhered to by the author. Automatic safety switching is an alternative, and rather more suitable term. Although the system was primarily developed with a view to complete protection in rural areas, its use has been extended on the Continent to all installations, rural and urban. It is applicable to all types of installations and apparatus and all A.C. and D.C. circuits up to 500 volts. Very small leakage currents of a few milliampères are sufficient to operate the protective devices, irrespective of their capacity.

Isolation is effected by means of switches designed to take the place of the normal main or circuit switch or switch fuse in the circuit that is to be protected, and the very small leakage current operates a trip switch which opens the circuit on all poles. The use of these devices involves no radical departure from standard practice, but instead of the main earth wire being taken direct to the earth, it is connected to the trip coil, and then taken to the earth connection. The system can therefore be applied to any existing installation that is already protected by ordinary solid earthing, the earth wire being simply cut so that the earth current is made to pass through the trip coil.

Apart from the very small current that is needed to open the circuit, isolation is effected on all poles simultaneously in about 1½ to 2 periods of the supply current. The tripping current, the author explains, is so small that it can be passed through the human body and the apparatus is often tested by Continental engineers by the simple expedient of placing one hand upon a live terminal and the other on the frame of the motor, when immediate disconnection follows. The fact that this method of testing is harmless is attributable mainly to the fact that the circuit is opened very rapidly. Another interesting fact to which the author directs attention is that the earth connection or complete earth circuit may have considerable resistance. Its resistance may, in fact, be several hundred ohms, but the lower the resistance the better is the protection that is afforded. An experiment described to test the automatic switch consists of connecting an ordinary H.T. wireless battery in series with the trip coil and a resistance which can be reduced in small steps from about 2000 ohms down to zero. With the maximum amount of resistance in circuit, the trip will probably fail to operate, but as the resistance is reduced step by step, corresponding to an incipient leakage fault gradually growing worse, it will be found that the trip will operate at some point between 1000 and 500 ohms.

The proposal to introduce the system in this country, the author states, is receiving considerable support, as the electrical development of rural areas has shown the urgent necessity for some such form of protection. The satisfactory performance of the apparatus has been demonstrated on over 100,000 installations abroad, but, as the author admits, electrical accidents have been remarkably rare in this country. The reasons given for this satisfactory state of affairs are (1) most supplies that have been given up to the present have been D.C.; (2) electricity has been employed mainly for lighting and industrial power-driven machinery; whilst extensions into rural areas have been small and are comparatively recent. The author might have added that great care is taken in this country to make electrical installations safe. It is considered, however, that failure of insulation will undoubtedly take place sooner or later on farms, and that this new improved system of protection is desirable. No apparatus of this kind is at present available in this country, but English firms are said to have sought licences to manufacture it, and it is expected that it will be put upon the market in the near future. The book also deals with other methods of protection, and it can scarcely fail to prove of value to those who are anxious to protect users of electricity against dangerous shocks.

BOOKS RECEIVED.

The Roads of England. By R. M. C. Anderson. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 8s. 6d. net.

Modern Farm Buildings. By D. N. McHardy. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 8s. 6d. net.

High-speed Diesel Engines. By P. M. Heldt. London: Iliffe and Sons, Ltd., Dorset House, Tudor-street, E.C. 4. Price 22s. 6d. net.

The British Steel Industry. By H. S. Jevons. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 1s. net.

Dynamics of Engine and Shaft. By R. E. Root, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 18s. 6d. net.

South African Mining and Engineering Year Book, 1932. London: Argus South African Newspapers, Ltd., 72–78, Fleet-street, E.C. 4. Price 21s. net.

Rhodesian Mining and Engineering Year Book, 1932. London: Argus South African Newspapers, Ltd., 72–78, Fleet-street, E.C. 4. Price 10s. 6d. net.

Bauxite and Aluminous Laterite. Second edition. By C. S. Fox, D.Sc., M.I. Mech. E. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 30s. net.

Foundrywork and Metallurgy. Parts V. and VI. Edited by R. T. Rolfe, F.I.C. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 6s. net each.

Dielectric Phenomena: III., Breakdown of Solid Dielectrics. By S. Whitehead, M.A. Edited by E. B. Wedmore, M.I.E.E. London: Ernest Benn, Ltd., 154, Fleet-street, E.C. 4. Price 30s. net.

Practical Surveying. Fourteenth edition. By G. W. Usill, A.M. Inst. C.E. Revised by Colonel Sir Gordon Hearn, R.E. London: Crosby Lockwood and Son, Stationers' Hall-court, E.C. 4. Price 8s. 6d. net.

Description of the Cost Accounting Scheme Introduced in the Locomotive Workshops at Moghalpura. By A. E. Howell, A.M.I. Mech. E. Calcutta: The Manager, Government of India Central Publication Branch. Price 2s. 3d. net.

A Text-book on Roofs and Bridges: Part II., Graphic Statics. Fifth edition. By the late M. Merriman and H. S. Jacoby. Revised by E. E. Ebling. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 20s. net.

The Nomogram: The Theory and Practical Construction of Computation Charts. By H. J. Allcock, B.Sc., &c., and J. R. Jones, M.A., &c. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 10s. 6d. net.

"THE METALLURGIST."

The April number of our Supplement, The Metallurgist, which is issued with the present number of The Engineer, deals with a wide range of metallurgical subjects which are of interest to the engineer. A leading article on "High Temperature Research" refers to the important programmes for further study of this subject which are being undertaken in America, and pleads for international co-ordination of effort in order to avoid wasteful duplication of work. A second leading article refers to the recent discoveries which have shown that chemical actions enter into many things which were formerly regarded as purely mechanical, abrasion being especially important, and urges more careful attention to the chemical aspects of ordinary engineering processes. Other articles relate to recent publications, containing new research results, and deal with accurate X-ray measurements in the study of alloy crystal structure, the electro-deposition of alloys, the very difficult problem of determining the internal stresses in cold-drawn tubes, intergranular corrosion in high nickel chromium steels, elastic measurements in solid and liquid metals by acoustic methods, the gas content of cast iron, blackheart malleable iron castings, the standardisation of the notched-bar impact test and the ageing of soft steel sheet. There is also the first part of an article by Dr. Rosenhain on "Some Principles of Testing," and a full review of a monograph on "Zinc and its Alloys," recently issued by the United States Bureau of Standards.

Letters to the Editor.

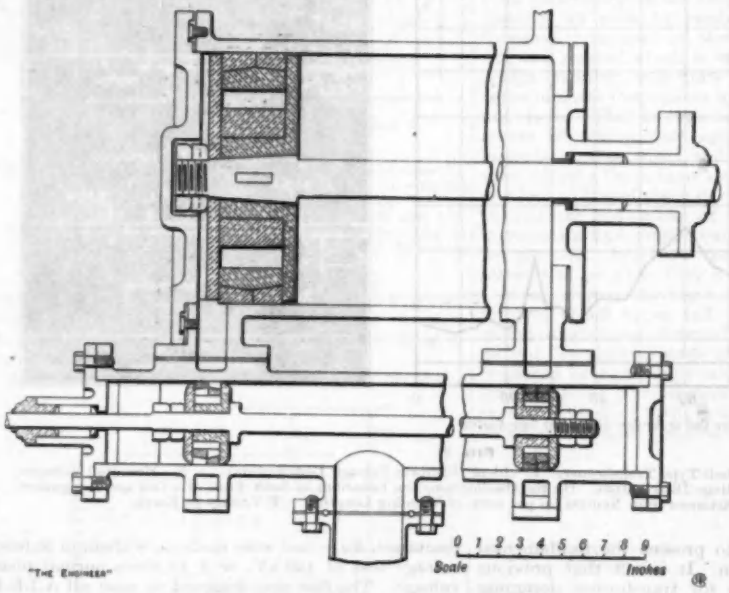
(We do not hold ourselves responsible for the opinions of our correspondents.)

PISTON AND LONG-STROKE VALVES ON LOCOMOTIVES.

SIR,—A locomotive cylinder with piston valves and direct steam ports is illustrated on page 285 of Robert Stephenson and Co.'s "Century of Locomotive Building," published in 1923. Since that date the firm has come into possession of a letter showing that these were actually tried on an engine for the Liverpool and Manchester Railway.

Robert Stephenson writes from Newcastle on February 4th, 1832: "I had one of the Atlas engines tried the other day for several hours, the valve cylinders are cast with two upright bars to keep the slit in the ring always opposite a solid part. They were completely tight and continued so. The pistons are also made to travel further and the overlap is made correspondingly greater. I did not know what to do with these engines, the [risk ?] of the cylinders wearing is lessened considerably, the overlap being increased, and I thought it unfair not to give them a fair trial again. In the end I resolved to send with the engines a set of common slide nozzles ready fitted up for putting in in case of the wearing taking place again. The engine is therefore coming with the piston valves in the improved form, and also a set of common slides to put on without loss of time in case of need. A set of slide valves are also sent with the engine for the Atlas."

From this letter it appears that two engines had been built with piston valves. That the device was adopted in order to reduce pressure and frictional resistance of the



STEPHENSON'S PISTON VALVE OF 1832

valve, is suggested by the following P.S.: "I have got a new slide valve contrived of the common kind to avoid the pressure of the steam also. It may either be in the form of two common slides placed back to back with packing between them or of a piston, the steam exhausting through a hollow piston."

About the same time Robert Stephenson and Co. supplied the Leicester and Swannington Railway with a winding engine having piston valves. The engine is illustrated in Stretton's "History of the Midland Railway," and Sir Henry Fowler in 1927 stated at the Institution of Mechanical Engineers that it was still occasionally employed as an "economical and commercial proposition," and "it will be a long time before it needs extensive repairs." It would be most interesting to know whether the piston valve rings are of the original contemporary type shown on the maker's locomotive cylinder drawing of 1832.

Regarding the adoption of long travel and therefore long lap to give free exhaust, the early investigations of Edward Woods, locomotive superintendent of the Liverpool and Manchester Railway, are recorded in his paper before the Civil Engineers, "On the Consumption of Fuel and the Evaporation of Water." As the result of his experiments, commencing in 1838, he increased the lap from nil to 1in. by various stages, of which he states: "Every step towards increasing the 'lap' was thus found to conduce to the good working of the engine. The waste steam was no longer choked up in the cylinder. . . ."

The lap of the locomotive slide valve thereafter became stabilised at about 1in., and so remained generally for half a century. But Robert Sinclair, locomotive superintendent of the Caledonian Railway, had adopted a long lap and travel before 1850, in view of its "peculiar importance," in "unquestionably facilitating the free exhaust of the steam at high speed." On this theory, Conner's Caledonian engine illustrated in Colburn's "Locomotive Engineering," Plate VIII., had a valve lap of 1¼in.

It may be that the principle of increasing the travel, and therefore the lap, had no greater application because it directly increased the load on flat valves, which were inevitably becoming larger and having to carry increasing pressures as well. The adoption of the piston valve obviated this difficulty, but it was left to Mr. Churchward, on the G.W.R., to make the happy combination of piston valve and long lap which has proved so successful in recent years.

Locomotive history is full of novelties and delightful surprises. The present writer will always remember the cheer which greeted the drawing of Stephenson's piston valve of 1832, when it was shown on the screen to a large assembly of locomotive engineers during the Railway Centenary celebrations in Darlington in 1925.

J. G. H. WARREN.

Bath, April 22nd.

INSPECTION.

SIR,—The difficulty of the high cost of inspection, mentioned in the letter signed by "Engineer" in your last issue, need not arise, for the arrangement of work in the office of any inspecting engineer with a good practice is either (1) to have members of his staff in each of the important centres of this country and on the Continent, or (2) to have standing arrangements with local inspectors in each of the centres. Without such organisation, no inspecting engineer could build up a large practice, for the very simple reason that the extra costs of time and travel would increase the cost of inspection above its proper value.

INSPECTING ENGINEER.

April 22nd.

THE DOWSER'S ART.

SIR,—I am indebted to your correspondents, "M.I. Mech. E." and Mr. T. Pardoe for their evidence, but fear that the sum of same is inconclusive. I am not, however, any scoffer, the miracle of "wireless"—despite the dreary broadcast programmes and the patronising intonations of "Uncle Egbert"—has, I think, convinced many of us of the existence of forces but dimly comprehended, and personally I see nothing strange in the development of a water-finding sense on the accuracy of which in earlier times the existence of the community might well depend. Surely the story of Moses and the Rock may well be the first authenticated account of water divination, and the twig used to-day the direct descendant of the rod there mentioned; at least that explanation is quite acceptable to me.

The point, I think, at issue, is not so much the existence of this sense, as its reliability in modern man, with serious expenditure in view if the dowser should prove in error. I understand there are professional dowsers who are usually paid on results, but as they, I think, do not share in the losses in event of failure, this in itself is no proof of *bonâ fides*. I would submit seeing the outlay possibly at stake, that dowsers operating professionally might well be licensed after proper test, and I submit that a fair test would consist of driving them by a circuitous route in a windowless car over a number of our Thames bridges. Surely, if they fail to register even once on crossing so obvious an expanse of running water, their opinion can be of little real value in the case of subterranean accumulations or streams.

Since the art has, however, a certain recognition and so closely touches many engineering problems in connection with water supplies, it does seem to me worthy of serious and deliberate examination by one of our scientific bodies, not so much with a view to establishing its existence as its degree of reliability in individual examples, the question is, Will the professional dowser submit to such a test as proposed, and, if not, why not? I confess that I had hoped that one of these gentlemen would have entered this discussion in defence of his claims when your article first appeared, but so far they have elected to lie low.

S. P. CHRISTIE.

London, S.W. 7, April 23rd.

SIR,—Some years ago I discovered, quite by accident, that I possessed the power of water divining, and it has been useful to me on several occasions and so far has not failed to give correct results.

I have tested a good many of my friends, and find that this capability is much more general than I had supposed, and that quite a number of them reacted to underground water.

I have not, so far, been able to predict the depth at which water may be found, and no doubt this can only be attained by constant practice, and can therefore only be done by professional "dowsers."

I was, however, able by this means to discover an old water pipe supplying a pond in my own garden, which could otherwise only have been found by means of a good deal of digging. By dropping stones at the points where the reaction was strongest, I was able to plot the position and direction of this pipe, and the line of the stones was quite straight, corresponding to the line of the pipe, which was at once discovered by digging at one point on this line. I was able to save myself a good deal of expense by this investigation.

I have tried the experiment of holding the twig over a pond, but there was no response; and it was only when I stood over the water myself that the twig began to pull. The water trough experiment is, therefore, likely to be a failure, unless the "dowser" himself stands upon a plank placed over the trough. It is evident that the influence is transmitted through the operator's body, and that the movement of the twig is only the manifestation of it. The mere holding of the twig over water would be useless.

April 25th. M. INST. C.E., M.I. MECH. E.

THE ROAD AND RAILWAY DISCUSSION.

SIR,—Whilst most reasonable people will appreciate the difficulties the British railways are facing, owing to adverse trade conditions, the executive heads appear unable to grasp the position, and make the best of it. It is little use meeting at the Railway Clearing House and debating departmental ditties, or the articles of the Railway Acts, 1921, when the main objective should be how to get more revenue and more traffic. Bluntly speaking, the railways are amongst the few commercial undertakings which can afford the luxury of refusing business, except exactly on their own terms and at their own times.

An examination of affairs will reveal that there are many commodities now carried by road that would be more conveniently carried by rail, yet the railways continue to bewail their misfortunes, and make little effort to increase business. If British railway managers and their immediate assistants were put upon a commission basis, as part of their salaries, we might quickly see some drastic bids for rail traffic, and not as at present a dwindling trade all round or trains half loaded.

In regard to passenger traffic, the railways could considerably increase their returns if they so desired by fares based on reasonable limits. It is almost safe to state that on coastal and seaside routes an intensive fare campaign by the railways against road traffic would almost exterminate their competitors, if they so desired, in a season. Whatever rates per ton can be secured for traffic now passing the railways should be laid hold of; something in traffic is better than nothing. It is to be hoped that the railway executives are not assuming road traffic has done its worst to them, for with the coming of the Diesel-engined motor transport vehicle, competition may assume still more dangerous aspects.

April 25th. E. S.

RAILWAY SPEEDS.

SIR,—In your issue of 22nd inst. your correspondent "D. T. L." complains that the L.N.E. improvements receive less than due credit. I am far from wishing to belittle the merit of the refreshing accelerations scheduled by that company—and, for that matter, by the L.M.S., too—but both your correspondent's letter and your article on page 444 swing the balance too far the other way. "D. T. L." does not inform us how severe gradients "before Doncaster" enhance the difficulty of a 100-minute run from Grantham to King's Cross, nor on what basis he can establish a comparison between an average speed of 53·1 m.p.h. for 185·8 miles, with five stops, and one of 69·2 m.p.h. on a non-stop run of 77·3 miles. Turning to the article, the summary of gradients exaggerates their severity in several places. For instance, the five-mile fall—it is really 5¾—from Potter's Bar to near Hatfield is not at about 1 in 200; less than half of it is anywhere near that figure, and an appreciable length in the middle is nominal—one short stretch actually rises. Again, the 1 in 200 fall from Stevenage extends only to just beyond Cadwell Box, about 33½ miles from London, and the rest of the fall to Arlesey is much gentler. Even Stoke Bank, stiff as it is, is not so bad as described; for some distance after Essendine the gradients are moderate, and there is a level ¾ mile past Corby before the final 1 in 178 begins. This is not to deny that the G.N. is a hard route, but there is no object in making it appear harder than it is.

HORACE MYERS, Major.

London, N.W. 3, April 25th.

BOOKS OF REFERENCE.

The Mercantile Year Book and Directory of Exporters, 1932. London: Lindley Jones and Brother, Ltd., 32, Bishopsgate, E.C. 2. Price 20s. net.—Adverse and uncertain conditions in the export trade have by no means decreased the value of this book of reference, and the forty-fifth edition is as complete and comprehensive as its predecessors. It is divided into the following seven sections:—Walking Guide, Alphabetical List of London Merchants, Goods Shipped from London, Provincial Shippers, Continental Shippers, Overseas Importers, Where to Buy. We have found this to be a very reliable book, and the information it contains is presented in such a form to be readily of service to all connected with the export trade.

Transient Voltage Stresses in Power Transformers.

By K. K. PALUEFF.

No. I.

THERE are three principal causes of difficulties in making transformers of conventional designs to withstand stresses produced by lightning, switching, and other transient voltages. One cause is the high amplitude of transient voltages present on transmission lines. This amplitude often attains values in excess of ten times normal voltage. The second cause is extremely non-uniform distribution of transient voltages along transformer windings. It is a common occurrence for a single travelling wave with a steep front and a given amplitude to cause local stresses within transformer windings of from a few to hundreds of times those that would be produced by a voltage of the same amplitude but at an operating frequency. The third cause is that a surge consisting of a train of waves of even relatively low amplitude creates cumulative oscillations in windings resulting in extremely high local stresses. This occurs where the frequency of a surge happens to be near that of one of the many natural frequencies of a transformer. The problem is further complicated by the fact that the location of these high stresses in a given transformer shifts with the changes in shape of travelling waves, or with changes in the frequency of the surge.

Theoretical and experimental studies of transformers of different types and sizes conclusively show that transient voltage stresses cannot be reduced appreciably by changes in relative dimensions or in arrangement of the winding as a whole, or of any of its composite parts, such as turns, conductors, or coils. For the reduction of turn-to-turn stresses the so-called "electrostatic ring" is effective only at the first two or three coils at the line end of a winding. The claims made by some investigators that it produces nearly

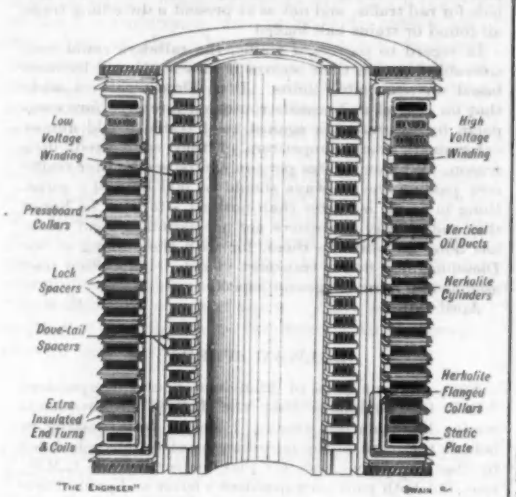


FIG. 1—SECTION THROUGH TRANSFORMER WINDINGS

uniform voltage distribution throughout the entire winding are in conflict with theory and experimental results. Protective devices consisting of a combination of inductance, capacitance, and resistance, in one form or other, have been proposed from time to time, and these have had the general name of "surge absorbers." Consideration of the phenomenon and of the nature of the devices as built lead to the following conclusions:—(*a*) Under certain conditions common in practice the device will appreciably increase local stresses produced by lightning waves in the winding. (*b*) Under other equally common conditions it will act as an extremely small capacitor which would very slightly slant the front of the lightning surge. This, however, is too small to be of practical interest, particularly in the case of high-voltage "absorbers." (*c*) Under none of the most important conditions found in practice, except as a result of an unusual coincidence, can such a device prevent or appreciably reduce internal oscillations of inductive windings, whether it be those of a transformer, generator, or any other piece of apparatus.

Since lightning arresters of various makes are not all equally effective—either on account of their inherent characteristics or of their location and connections—and because of their inability to protect transformers from voltages produced by lightning striking the line in the neighbourhood of the transformer, it appears desirable to have a transformer in which the violent internal oscillations are absent and voltage stresses for all points of the winding can easily be predetermined. Accordingly, a non-resonating transformer has been developed. In this type of transformer surge voltages of any character distribute uniformly along the entire winding. This permits the most effective use of insulation, resulting in a marked increase in the overall safety factor. That such a transformer, when built for commercial use, is self-protecting was demonstrated by artificial lightning tests on one of fourteen 13,000-kVA, 230-kV transformers built for the New England Power Company. During these tests a considerable number of lightning waves of amplitude in excess of the maximum allowed by the co-ordinated transmission line insulation were applied, without injury to the transformer.

The ordinary induced potential test applied to earthed neutral transformers does not stress various parts of the insulation of an ordinary transformer to values equivalent to those produced by transient voltages in service. For example, a voltage to earth produced during such a test falls uniformly from maximum at the line terminal to zero at the earthed neutral, while a lightning wave or a switching surge produces voltages throughout the winding which may be equal to the applied voltage or even higher. For this reason it is considered a hazardous practice to grade insulation from the high-voltage winding to earth, and to the low-voltage winding, in proportion to the test voltage along the winding. In a non-resonating transformer the voltage distribution produced by the induced voltage test is identical to that produced by transient voltages. Therefore, only in such a transformer does this test subject the insulation throughout the winding to stresses equivalent to those found in service. Increasing the lightning strength of the insulation at the line end only of a transformer winding over the lightning strength of the transmission line insulation does not necessarily prevent an internal lightning failure of the transformer, unless it is of the non-resonating type.

The interest of the electrical industry in the non-resonating type of transformer has become so general

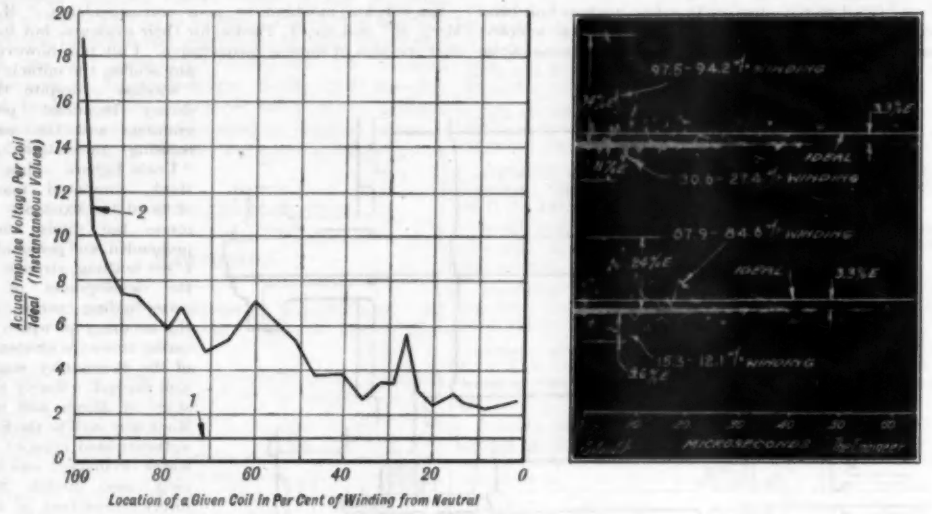


FIG. 2

Voltages across Coils in Shell-Type Transformer. 1.—Ideal (Uniform Voltage Distribution). 2.—Measured Voltages Compared to Uniform Voltage Distribution. On the Oscillograms the Locations of both Ends of a Coil are Designated by their Distances from Neutral (in per cent. of Winding Length). E Voltage to Earth.

that it seems desirable to present the fundamental facts about it once again. It is felt that previous publications 1–4* suffice for transformer designing engineers. However, it has been found that these papers are not of much use to operating engineers, who are not particularly interested in the details of the phenomena, but wish to know the fundamental facts. The present contribution is an attempt to satisfy the demands of such readers.

There are more than 2,000,000 kVA of non-resonating transformers in operation, some of which have passed five lightning seasons, and no trouble has been experienced with any of them. In judging the practical importance of various harmful phenomena, such as short-circuit forces, short-circuit heating, transient voltages, &c., the number of transformers damaged by a given phenomenon, expressed in per cent. of the total number of transformers in service, is quite often used as a criterion of the practical importance of the phenomenon under consideration. It would seem to be more nearly correct to express the failures caused by any given phenomenon in per cent. of total failures from all causes. While this is true for all kinds of apparatus, it is particularly true for transformers, because in them the most severe stresses—due to short-circuit and transient voltages—are produced by accidental causes of very short duration, and the magnitude of the stresses depends not only upon the transformer characteristics, but also upon the characteristics of the network. When the importance of transient voltages is considered it must be remembered that many of the failures of transformers that are caused by transient voltages are not attributed to them because of lack of data on the occurrence and magnitude of switching, lightning, and other surges impressed upon a transformer during its life.

* (1) "Effects of Transient Voltages on Power Transformer Design," K. K. Paluoff, "A.I.E.E. Quarterly Trans.," Vol. 48, July, 1929, page 681; (2) "Lightning Studies of Transformers by the Cathode Ray Oscillograph," F. F. Brand and K. K. Paluoff, "A.I.E.E. Quarterly Trans.," Vol. 48, July, 1929, page 998; (3) "Effect of Transient Voltages on Power Transformer Design," K. K. Paluoff, "A.I.E.E. Quarterly Trans.," Vol. 49, July, 1930, page 1179; (4) "Effect of Transient Voltages on Power Transformer Design," K. K. Paluoff (Winter Convention of the A.I.E.E., New York, January, 1931), "A.I.E.E. Quarterly Trans." Vol. 50, June, 1931, page 803.

Only the very largest transformers have normal operating voltage between adjacent turns of 300 or 400 volts, and in the majority it is below 100 volts, and 100 volts at operating frequency is not capable of breaking through a single sheet of ordinary cigarette paper in air, much less of breaking it down under oil. It must, therefore, be agreed that any insulation failure in a transformer must be precipitated by a transient voltage stress. It is obvious, therefore, that voltages many times normal must be present in a transformer to damage its insulation. This is especially true of turn and coil insulation, which, in properly designed transformers, have extremely high safety factors.

Another factor that is responsible for obscuring the true danger of transient voltages is the fact that after the insulation is damaged by a surge of limited energy, it may take several days and even months before the operating voltage will establish a current through the failure of sufficient magnitude to develop into a short circuit and make the failure apparent. In spite of these characteristics, various statistics of failures of apparatus in the United States and other countries show that something like half of all transformer failures are caused by transient voltages. The effect on transformer cost and size of taking transient voltages into consideration can be judged from a specific example. A number of years ago two designs of 20,000-kVA, 220,000-volt transformers were made for earthed neutral operation. These two transformers had identical operating characteristics—efficiency, reactance, &c.—and were made to withstand induced voltage test of 440-kV, or 3·46 times normal phase voltage. The first was designed to meet all A.I.E.E. tests and requirements, and would operate successfully on a system free of transient voltages. The second transformer met the same requirements, but, in addition, the insulation strength between turns, coils, and from winding to earth was increased to the values required by abnormal stresses due to transient voltages, in accordance with practice followed by the General Electric Company of America for normal insulation for such a transformer.

The additional insulation allowances in the second transformer caused an increase of 40 per cent. in cost and 70 per cent. in displacement over that of the first. The principal cause of this difference was the grading of insulation in the first transformer from high-voltage winding to low-voltage winding, and to earth. All standard requirements and tests allow this insulation to be decreased uniformly from a maximum at the line terminal to a minimum at the earthed terminal, in the order of stresses produced during the induced voltage test. As will be shown later, such grading of insulation is not justified by transient voltage stresses encountered in service.

GENERAL CONSIDERATIONS.

It is now a generally accepted fact that windings of an ordinary transformer—Fig. 1—when subjected to transient, or high-frequency, voltage excitation, undergo a violent internal oscillation, resulting in extremely non-uniform distribution of the applied voltage, whether produced by a single travelling wave, like those due to lightning, or by a train of waves like those produced by switching surges or arcing earths. Various adjacent members, such as turns or coils, are frequently raised to potential differences from ten to one hundred times their normal share of the terminal voltage. This highly non-uniform voltage distribution is illustrated in Fig. 2, the data for which were obtained on a large shell type transformer. Similar abnormal stresses are found in all other transformers, with the exception of the non-resonating type.

It is also a generally accepted fact that even in a solidly earthed transformer, a single lightning wave can produce voltages to earth throughout the winding

far in excess of the uniform voltage distribution shown by line 2 of Fig. 3. Odd as it may appear at first, the internal voltages so produced may even exceed the applied voltage, as shown by curve 4, Fig. 3. Experimental and theoretical investigations also show that

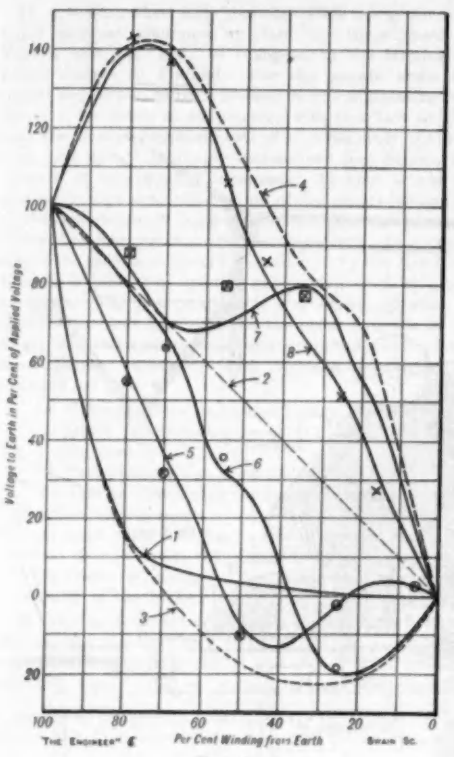


FIG. 3

Voltage Distribution Produced in an Ordinary Transformer by a Single Travelling Wave (Neutral Earthed). 1.—Initial or Electrostatic Distribution. 2.—Final Distribution. 3 and 4.—Envelope of Oscillations. 5, 6, 7, and 8.—Distribution at 3, 6, 12, and 18 Microseconds after Impact of the Wave. The Curves are Calculated and the Points Taken from Test Data.

damped oscillations, such as are caused by switching surges and arcing earths, may produce voltage resonance within transformer windings, resulting in especially high local stresses.

All these abnormal voltages are caused by the com-

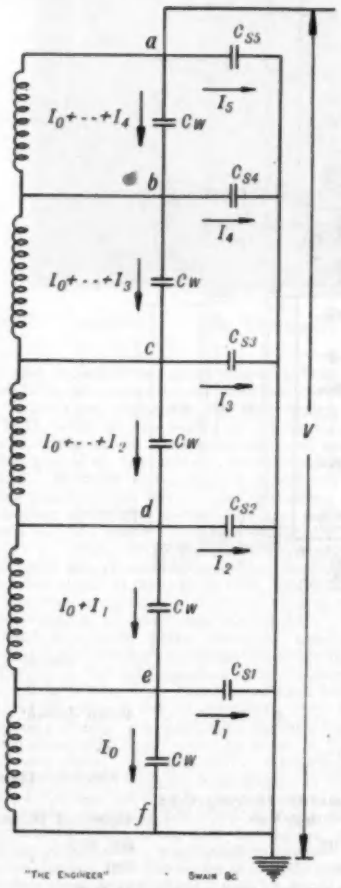


FIG. 4

Approximate Equivalent Circuit of High Voltage Winding of Ordinary Transformer.

bined effect of distributed inductance of winding and of the electrostatic capacitance between adjacent parts of the winding and from the winding to core and tank—see Fig. 4. The voltage at operating frequency distributes uniformly only because the charging current of these capacitances is negligible at low frequencies, as compared to the inductance current that flows along the conductor of the winding. For example, if we assume that at 50 cycles per second the inductance current in a transformer winding is 100 ampères, and the capacitance current 1 ampère, it is obvious that the effect of the latter current would be negligible. However, at a frequency of the nature found in switching surges, say, 5000 cycles per second, the inductance current will become 1 ampère, since it is inversely proportional to the frequency of the applied voltage. The capacitance current will become 100 ampères, since it is directly proportional to the frequency of the applied voltage. Obviously, if the capacitance of the winding were connected in multiple with the inductance of the winding only at the transformer terminals, then in the latter case the capacitance would entirely dominate the phenomena and the effect of the inductance would be negligible.

Unfortunately, the capacitance path consists of a great many separate capacitances. Some of these are connected in shunt with inductance elements of the winding, and some are between winding and earth—Fig. 4. For this reason a transformer winding reacts, to the frequencies well above normal, as a complex network of distributed inductances and capacitances. It has been found through theoretical and experimental study that every ordinary transformer has a number—ten or more—of so-called natural frequencies, which are capable of producing particularly high voltages within the winding, owing to resonance conditions. These frequencies vary over a very wide range, the highest being perhaps a hundred times that of the lowest in a given transformer. These natural frequencies depend upon the number of turns, dimensions of the conductors, turn insulation, coil insulation, dimensions of the coils, distance between coils, distance of coils to earth, mean length of turn, terminal conditions of the secondary winding, &c. For this reason, which is evident to any experienced design engineer, it is quite impossible to control the order of these frequencies in ordinary transformers of any type. This is true because the other requirements of transformer operation, such as heating, losses and reactances and insulation tests, impose very definite limitations on the dimensions and proportions of transformer parts, thus making control of the natural frequencies of transformers by means of distribution and proportioning of winding impossible. In practice, therefore, the natural frequencies are allowed to be what they will.

It so happens that the natural frequencies of transformers of all types fall within the range of frequencies of surges observed on transmission systems. As will be shown, some reduction in local stresses produced by lightning could be gained if the natural frequencies of transformers were kept not much in excess of 2000 or 3000 cycles per second. Table I. shows the natural frequencies and periods of transformers tested by several investigators. It illustrates the fact that the natural frequency of transformers is not restricted to any particular range that is advantageous from the standpoint of voltage stresses, and as a rule is well in excess of 3000 cycles per second in all types of transformers. Furthermore, a greater portion of switching surges are of relatively low frequency, and therefore transformers with a low natural frequency are particularly susceptible to resonance with this type of transient voltage.

TABLE I.

Natural period measured by	kVA.	Voltage.	Type.	Lowest natural frequency f_1 in cycles per second.	Period of f_1 in micro-seconds.	Length of lightning wave which will produce voltage to earth above line uniform distribution (Curve 2, Fig. 3).
K. K. Palueff	2,000	12,000– 1,750	Shell	40,000	25	5
K. K. Palueff	2,500	44,000– 377	,,	33,400	30	6
K. K. Palueff	3,300	66,700– 4,360	Core	33,200	30	6
K. K. Palueff	23,300	66,400–13,200	,,	16,700	60	12
K. K. Palueff	12,000	110,000–11,550	,,	12,900	78	15·6
J. K. Hodnette	—	—	Shell	12,500	80	16
K. K. Palueff	1,000	44,000– 2,400	,,	11,000	91	18·2
K. K. Palueff	22,000	154,000Y–13,200	Core	10,500	95	19·0
K. K. Palueff	6,670	115,000Y– 8,800	,,	9,000	111	22·2
J. Fallou	25	12,500– 230	—	8,500	118	23·6
J. K. Hodnette	667	66,000– 7,000	Core	6,700	149	29·8
K. K. Palueff	5,000	88,000– 377	Shell	6,250	160	32
K. K. Palueff	15,000	66,000–13,300	Core	6,000	167	33·4
J. K. Hodnette	3,000	140,000– 5,000	Shell	5,000	200	40·0
J. Fallou	4,000	70,000– 7,000	—	3,000	333	66·6
J. Fallou	275	250,000– 500	—	1,330	752	150·0

Mechanism of Oscillations Due to Unidirectional Waves.

The voltage distribution produced in a transformer winding by a long unidirectional wave with steep front can be divided into three stages, namely, initial or electrostatic, oscillatory, and final. During the initial stage practically the entire applied voltage concentrates across a few per cent. of the winding turns at the line end—Curve 1, Fig. 3. The oscillations that follow create very high local stresses between turns and coils at points throughout the entire winding, as well as high potentials from the winding to earth—4, 5, 6, 7, 8, Fig. 3. During this period, the potential of each point of the winding oscillates between the limits shown by Curves 3 and 4 of Fig. 3. After the oscillations are damped out by losses, the voltage distribution becomes uniform, as is shown by Curve 2. This is the third and final stage of the phenomenon, provided the terminal voltage is maintained at its maximum value.

(To be continued.)

Canadian Engineering News.

Manitoba's Metal Industry.

The annual report of the Hudson Bay Mining and Smelting Company for the year 1931 reflects the difficulties besetting the base metal producers throughout the world, but shows a marked improvement in the physical condition of the company's properties at Flin Flon, Northern Manitoba. Salient features brought out in the report were the company's ability to sell its full metal production, an improvement in the grade of ore mined, lower operating costs, and a strengthening of the company's working capital position. The company milled 1,090,596 tons of ore during 1931, which averaged 0·089 oz. of gold per ton, 1·09 oz. silver, 1·94 per cent. copper, and 3·82 per cent. zinc, and produced 73,000 oz. of gold, 702,128 oz. of silver, 31,068,556 lb. of copper, and 35,056,199 lb. of zinc.

St. Lawrence Water Levels.

Continuation of the dredging operations designed to give the St. Lawrence River a 35ft. ship channel from Montreal to the sea, with particular reference to improving the curves, was a recommendation contained in the report of Sir Alexander Gibb, who investigated port conditions in Canada for the Dominion Government. Particular attention was given to the effect upon Montreal of the St. Lawrence deep waterways project, and a recommendation was made that a special river commission should be appointed and be given executive powers, similar to those of the body controlling the Mississippi River and some of the great inland waterways of Europe. A great deal of attention was devoted to the St. Lawrence water levels and the St. Lawrence ship channel, and there were detailed comments on the existing situation, in which the serious aspects of lessening the depths in the channel were referred to. Sir Alexander urged that everything possible should be done to secure a more stable maintenance of the river levels and suggested that all services should be co-ordinated under one authority and that a more organised study should be made of the subject, with experiments conducted on a large scale to determine various factors entering into it.

Large-power Derrick Vessel.

The "Foundation Scarboro," a powerful derrick ship built during the winter months at the yard of Canadian Vickers, Ltd., Montreal, will be capable of handling a load four times that of the 75-ton floating crane of the Harbour Commissioners of Montreal. The new derrick vessel will be capable of lifting over 300 tons and will be more powerful than any vessel of the kind in Canadian waters with the exception of the pontoon gate lifter stationed at the new Welland Ship Canal. The vessel will be electrically driven throughout, primary power being supplied by twin "Atlas" oil engines of 200 horse-power each connected to 220-volt D.C. generators. The new derrick boat was designed by the engineering staff of the Foundation Company of Canada, and has a length of 100ft., width of 42ft., and moulded depth of 11½ft. Twin sheerlegs at the stern will each lift 150 tons, and on top of the derrick house there is a revolving crane with a capacity of 30 tons.

Radium Refinery.

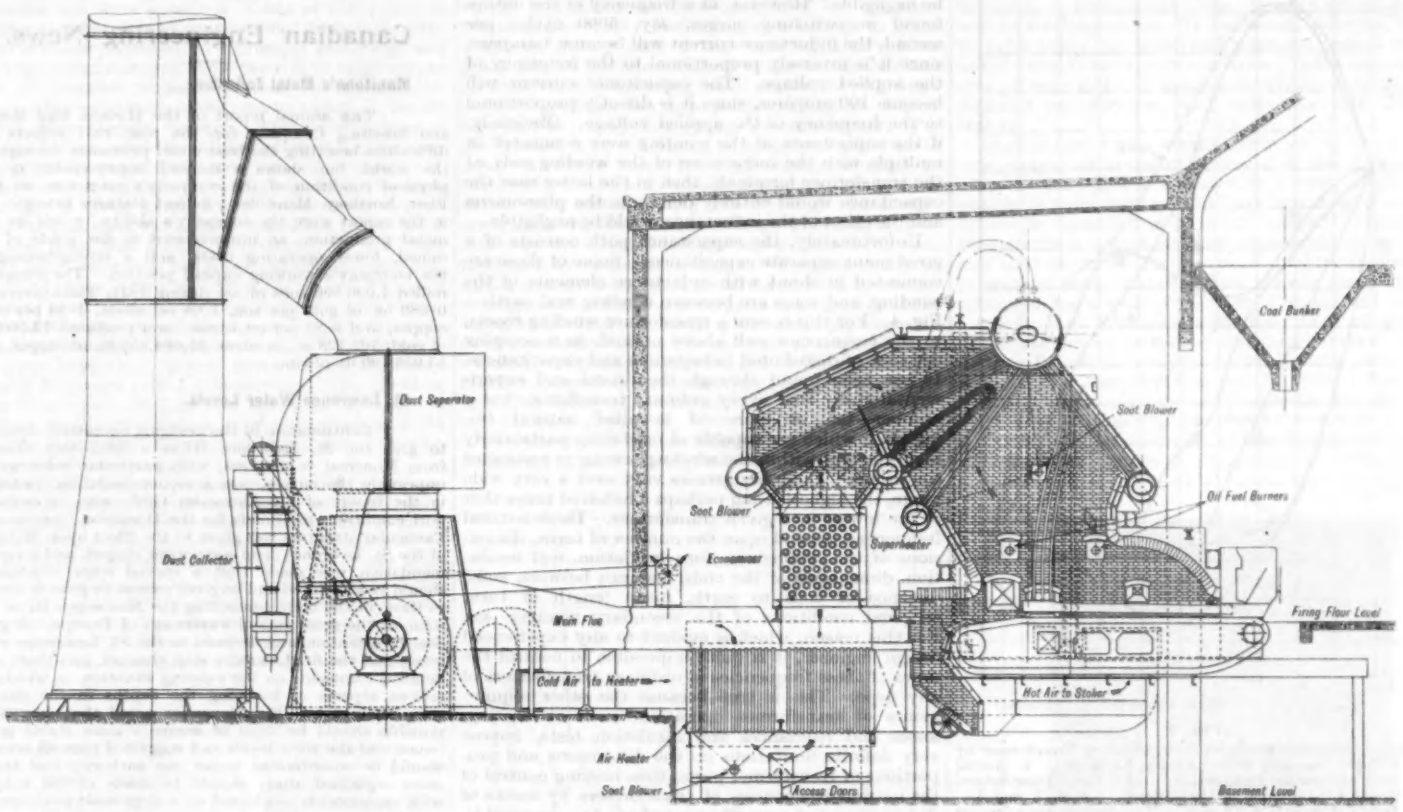
The directors of Eldorado Gold Mines are contemplating establishing a refinery in Ontario for the extraction of radium from Great Bear Lake pitchblende ore. It has been intimated that the company will concentrate on mining and exploration this year and that some high-grade silver ore as well as pitchblende will be shipped from the mines. In connection with radium extraction, the company has engaged the services of a Belgian expert, Monsieur Pochon, and on his return from Europe in June plans will be considered for a refinery.

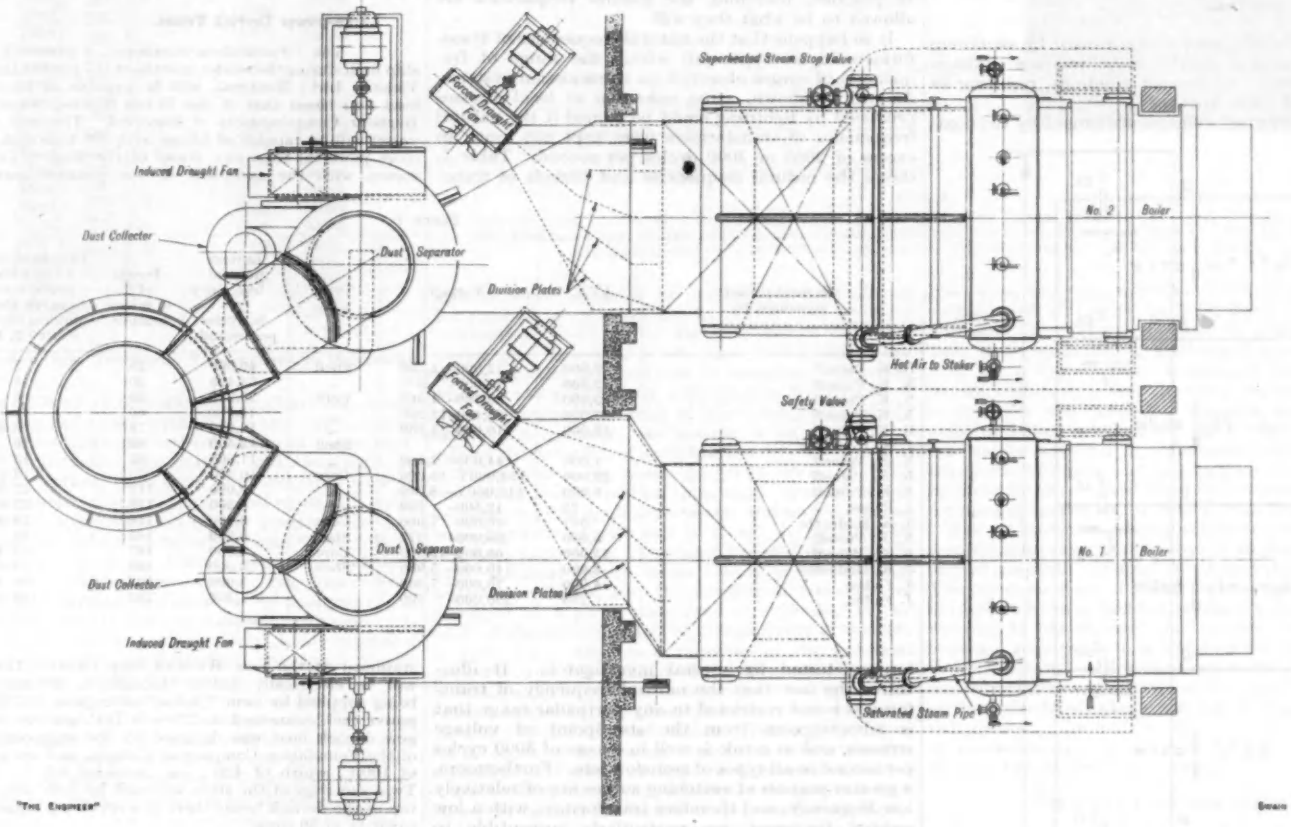
The Mersey Docks and Harbour Board has decided to expend £103,000 on a new sand pump hopper dredger. She will be 330ft. long, have a hopper capacity of 70,000 cubic feet, and a speed of 11 knots.

LAY-OUT OF BOILERS AT HELSINGFORS POWER STATION

YARROW AND CO., LTD., SCOTSTOUN, ENGINEERS

(For description see opposite page.





Boiler—

Heating surface	6750 square feet
Outside diameter of tubes	2in.
Designed pressure	355 lb. per square inch
Working pressure at present	184·5 lb. per square inch

Superheater—

Heating surface	1600 square feet
	[At present erected, 1000 square feet]

Grate—

Type:	Underfeed Stoker Co., Ltd., provided with pressure zones
Grate area	227 square feet
Width	13ft.
Length	17ft. 6in.
Drive	By an electric motor

Economiser—

Type: Green and Son, gilled single tube provided with plate casing

Heating surface	2355 square feet
Length of tubes	12ft.
Number of tubes horizontally	7
Number of tubes vertically	10
Free area for gases in economiser	31·1 square feet

Air Heater—

Type: Yarrow, M.S. tube, consisting of two parts.

Heating surface	7500 square feet
Length of tubes	6ft.
Diameter of tubes outside	2¼in.
Number of tubes, longitudinal	72
Number of tubes, crossways	26
Free passage for gases	32·8 square feet

Fans Motor driven

F.D. fan—

Type	"Sirocco," 42¼in.
Air quantity, 15·5 deg. Cent. or 60 deg. Fah.	43,500 cu. ft. per min.
Pressure	6in. w.p.
R.p.m.	720
Power consumption	85 H.P.

I.D. fan—

Type	"Sirocco," 80in.
Quantity of gas, 475 deg. Fah.	78,500 cu. ft. per min.
Draught	5½in. w.p.
R.p.m.	485
Power consumption	140 H.P.

Boilers at Helsingfors Power Station.

No. I.

IT is seldom that such thorough tests are given to a boiler as those undergone by plant recently supplied by Yarrow and Co., Ltd., of Glasgow, to the Helsingfors power station in Finland. For this reason alone the results are certain to be of interest to the engineering profession; but when in conjunction with that fact we find that the boilers supplied were of a remarkably compact form and gave exceedingly satisfactory test figures, the interest is considerably increased. In this article we propose to give some description of the events leading up to the installation of the boilers in the power station and of the main features of the boilers themselves. In a second article the results of the trials conducted by the Kraft och Bransleekonomi, a completely independent authority, will be given. The test programme was drawn up after an examination had been made of the usual methods in use in all the leading countries, and exhibited much of the thoroughness associated with German methods. It included :—

(*a*) Efficiency tests at various loads ;

(*b*) Quick steam-raising tests, (*i.*) using coal only, (ii.) using coal and oil ;

(*c*) Fuel consumption at no load ;

(*d*) Test for discovering the losses during a shut-down period of sixteen hours ;

(*e*) Load tests using (*i.*) natural draught only, (ii.) forced draught only, (iii.) induced draught only ; and

(*f*) Tests to ascertain the maximum evaporative capacity of the boiler.

All the trials were made between the latter part of October and the beginning of December last year. They were of an extensive character and those for the ordinary efficiency were carried out with exceptional thoroughness.

Owing to the growth of demand for the supply of electricity the load upon the Helsingfors power station in Finland had increased so much recently that between 1928 and 1931 the reserve power available became inadequate. The largest deficiency occurred during the first half of 1931, when at one period the peak load rose to 22,000 kW, while at the same time the total capacity of the boiler plant at the station corresponded only to 16,000 kW. In these circumstances it was obvious that the boiler plant would have to be extended. Another factor bearing upon the matter was the contemplated completion of the power line between Abberfors and Helsingfors in 1932. With the completion of this link the Helsingfors power station would be required to meet a peak load of about 24,000 kW in 1932, and it was consequently felt that to provide a sufficient reserve the plant should be capable of producing 30,000 kW. To meet such a load the boiler plant obviously needed to be extended, and the necessary investigations were instituted. The boiler-house already existing was constructed of concrete. It is known that alteration of such buildings is difficult and involves a risk of disturbing their stability. By scrapping a twenty-year-old boiler, inefficient as judged by modern standards, room could be made in the boiler-house for new plant. The possibility of building therein a high-capacity boiler with an evaporation in the neighbourhood of 70 kilos. per hour per square metre of heating surface, capable of burning 250 kilos. of coal per hour per square metre of grate area, and having an efficiency approaching 90 per cent., was therefore studied. Owing, however, to the fact that the house is of little height none of the boiler types investigated could be fitted into the space available unless steaming capacity was sacrificed. Since increased capacity was absolutely necessary, financial arrangements were made for the construction of a new boiler-house and the purchase of a boiler capable of providing 70 tons of steam per hour.

A number of firms quoted for generators of this capacity, and among the designs put forward that offered by Yarrow and Co., Ltd., had a height considerably lower than the others. The type offered by this firm had not previously been considered when investigations were being made of the possibility of placing the new boiler in the old house. The plant suggested was not suitable, but an examination of the effect of employing two boilers of this type, each of half the original capacity, *i.e.*, 35 tons of steam per hour, showed that in this way the requirements could be satisfactorily met in the old house. In due course, therefore, the contract was awarded to Yarrow and Co., Ltd., for two such boilers on the understanding that as much as possible of the work of making the parts and constructing the boilers should be done in Finland. The main contractors became Tammerfors Linne och Jernmanufaktur A/B, an old-established and one of the most important engineering firms in Finland. The arrangement was that Yarrow and Co., Ltd., should furnish the firm in Finland with designs and technical assistance for the work, at the same time constructing certain parts, such as forged drums, which could not be made in that country. Altogether the Tammerfors Linne och Jernmanufaktur A/B provided about 100 tons of material. A considerable number of parts and certain complete machines, such as electric motors, were supplied by other engineering firms in Finland.

By the arrangement adopted a heavy capital investment for the construction of a new boiler-house and the provision of ash transporters, water and steam pipes, &c., was avoided and the inconvenience of having the boiler plant divided between two houses, each with its own staff, avoided.

CONSTRUCTION OF THE BOILERS.

A complete arrangement drawing of the two boilers is given on page 482. Each has four transverse drums. The gases pass upwards through the top half of the rear bank of tubes and down through the lower half of the same bank to the economiser. They are then directed downward through the front half of the air heater, and upward again through the back half, travelling thence to the induced draught fan and the chimney. To attain economy of operation at the smaller loads a damper controlled from the firing floor level can be operated to allow the gases to by-pass the induced draught fan.

From a study of the drawing and the photographs reproduced in Figs. 1 and 2, on page 476, and 5 it will be seen that the boiler has a large furnace volume—actually 2473 cubic feet—while the front and middle banks of generating tubes take full advantage of the available radiant heat in the furnace. The saturated steam drum is 57in. in diameter, the rear water drum 30in. in diameter, and the front and middle water drums and the superheater drum are all 23in. in diameter. The steam drum is made of two plates, longitudinally connected by double riveted double butt straps, the thick plate in way of the tubes being machined down to the appropriate shell thickness in way of the joints. All the remaining drums are seamless forged shells with hemispherical pressed ends, the manhole flanges being formed during the pressing operation, so that only one heat is required. The end circumferential seams are double riveted and there are no intermediate circumferential seams. All the boiler tubes are straight and both they and the superheater tubes are expanded and bell-mouthed into the drums.

The basement houses the air heater, and the firing floor, upon which stands the economiser, is 12ft. above the basement floor. Besides that for the damper in the induced draught duct, mentioned before, other controls for the stoker air compartment dampers and the fan gears are all situated at the firing floor level. The speed of the grate can be varied within wide limits to suit the load, eight positive speeds being provided, whilst the driving motor speed can also be varied. Each of the boilers is fitted with a Cope's automatic feed water regulator. The ashpits are provided with rack and pinion-operated cast iron doors, through which the ashes are discharged into four-wheeled wagons running on a narrow-gauge rail track. A large soot hopper is situated under the air heater, the soot being removed through two cast iron hinged doors which open to the basement floor. Soot blowers are provided for cleaning the boiler tubes, the economiser tubes, and the air heater tubes. On the whole, owing to the low velocity of the flow of gases from the combustion chamber and the absence of horizontal ledges, the soot is not found to deposit in the gas paths through the boiler apart from the hoppers.

Each generator is equipped with four auxiliary Kermode oil burners. In the drawing and the photographs reproduced in Figs. 3 and 4, on page 476 the flue gas cleaning plant, the single chimney and the general construction of the power-house can be seen. The forced draught and induced draught fans are all situated in the open, and each boiler is equipped with an independent flue gas cleaning plant. In the drawing it should be noticed also that the forced draught is supplied to the stokers—constructed by the Underfeed Stoker Company, Ltd.—from a chamber having sectional regulation in six zones, each of which has its own air control.

The boiler is designed to work—see the table on page 482—at a pressure of 355 lb. per square inch, and to have an actual normal steaming capacity of 42,500 lb. per hour. Since the station is not at present suited to such a high steam pressure, a reduced pressure of 185 lb. per square inch at the boiler stop valves is being used. The designed steam temperature is 400–450 deg. Cent.—750–840 deg. Fah.—but until such time as the turbines are suited to such conditions the superheater surface has been reduced from 1600 square feet to 1000 square feet and the present steam temperature is 300–350 deg. Cent.—570–660 deg. Fah.

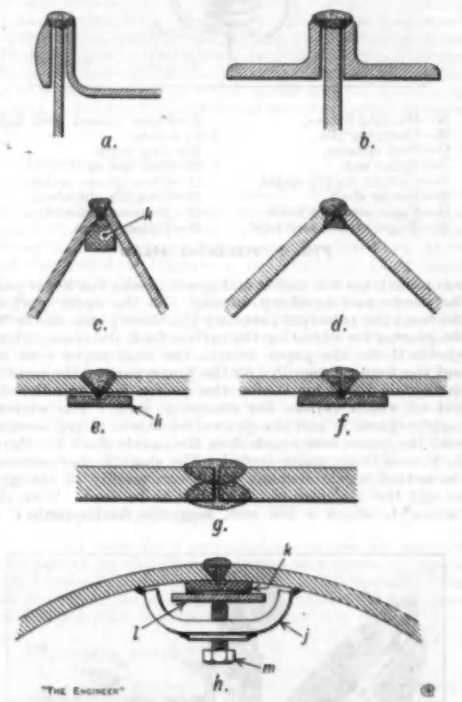
(To be continued.)

FIG. 5—FRONT END OF COMBUSTION CHAMBER

Automatic Carbon Arc Welding.

WITH the object of increasing the efficiency, economy, and utility of automatic welding plant, extensive research work has been carried out in Germany with a view to ascertaining to what extent carbon arcs are suitable on plant of this nature. While in the case of manual operation, a seam welded with a carbon arc is liable to be very brittle, the investigations have shown that if the process is made automatic, this defect can be overcome. It is essential to remove the oxygen surrounding the carbon by a burning process, and to ensure that the flame shrouds the melt. A special paper strand is therefore led past the arc, so that as it burns it shrouds the arc in its flame. The carbon must always be maintained at a suitable distance from the work, and it is therefore adjusted automatically, according to the loss by burning. By these means it is said to have been possible to produce welds with excellent mechanical properties.

The outstanding advantages claimed for the carbon arc are a much greater welding speed and a smaller degree of distortion, and as a result of the latter, clamping devices, which are complicated and tend to interfere with the process, can usually be dispensed with. With the carbon arc the uniting of the parts is done mainly by fusing the edges of the metal to be joined. Edge welds are therefore particularly amenable to the process. In order to increase the depth of fusion with thick sheeting and on special jobs a filling wire is fed through a nozzle to the core of the arc, whilst the metal that has free access to the arc is thoroughly melted. That part of the heat of the arc that is otherwise lost by radiation is used for fusing the filling wire.



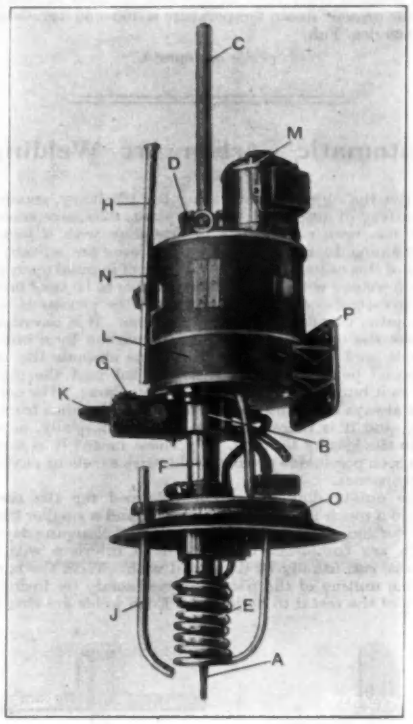
a—Edge weld.
b—Edge weld.
c—Edge weld with filling wire, single sided.
d—Edge weld with filling wire, double sided.
e—Butt weld with filling wire, single sided.
f—Butt weld without filling wire, single sided.
g—Butt weld without filling wire, double sided.
h—Butt weld, with copper strip placed in position.
j—Clamp.
k—Copper strip.
l—Face-plate.
m—Clamping screw.

FIG. 1—EXAMPLES OF CARBON ARC WELDS

Practical applications of the carbon arc process are illustrated in Fig. 1, where the welds *a* to *d* show the fusion of similar and different sections. Additional material is only necessary in the case of the joint *d* which is welded from both sides. The sheets in this case must overlap by a few millimetres, the top side being welded first and the bottom side afterwards. A base in the form of a copper strip *k* is, however, necessary in the cases of the welds *e* and *e*. With the butt welds *e* to *h* the carbon arc offers the advantage that sheets of more than 8 mm. thickness need only be bevelled if they cannot be welded from two sides. If welding is only done on one side,

however, a copper strip is essential. It prevents the material being burnt through, and it permits the thorough welding of sheets up to 15 mm. Experience has shown that it is good practice to provide the copper strip with a groove. When use is made of a copper strip, there is no need to clamp the work tightly by means of heavy clamping devices. As shown by the example *h*, it is sufficient for the strip *k* to be secured by a clamp *j*, which is easily placed in position. For supplying the arc D.C. generators are employed.

The most important part of any automatic plant is the welding head, which holds the carbon electrode and maintains the arc automatically in a suitable condition for the work. The paper strand mentioned must also be fed forward. The upper part of the head—Fig. 2—



A—Welding carbon.
B—Clamping jaw.
C—Feed spindle.
D—Splint nut.
E—Current supply spiral.
F—Nozzle shaft.
G—Paper strand wheels.
H—Paper strand feed tube.
J—Paper strand feed tube with nozzle.
K—Trip lever.
L—Gear casing.
M—Three-phase motor.
N—Coupling chamber.
O—Protective shield.
P—Fixing flange.

FIG. 2—WELDING HEAD

accommodates the motor and gearing, and the lower part the nozzle and auxiliary devices. At the upper part of the head the principal parts are the three-phase motor M, the gearing for adjusting the carbon feed, the transporting wheels G for the paper strand, the feed paper tube H, and the fixing flange P. At the lower part of the head is the nozzle shaft for taking the carbon feed spindle, the end of which carries the clamping jaws. The current supply spiral E and the protective shield O are secured with the paper feed nozzle J on the nozzle shaft F. Parts E, F, and O are water cooled. The shaft F also contains the actual nozzle element which can readily be changed to suit the diameter of the carbon to be used. With the carbon A, which is 500 mm. long, the feed spindle C is

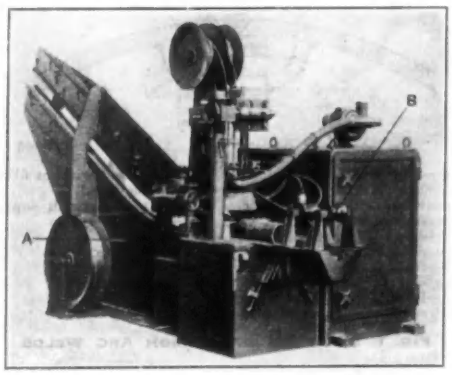
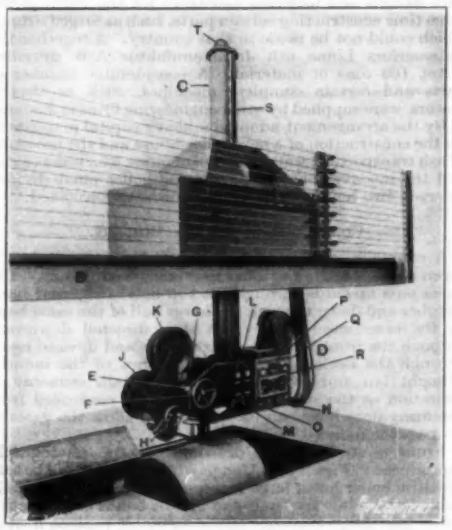


FIG. 3—TUBE WELDER

inserted in the welding head, so that the pointed carbon protrudes about 50 mm. out of the nozzle, and after the paper strand has been inserted the welding head is switched on. The carbon is then advanced until it makes contact with the work, and in order to strike the arc it is automatically withdrawn until the arc voltage for which the apparatus has been adjusted is obtained, the voltage being automatically maintained by the feed of the carbon. The paper, which is led to the arc, burns and serves the purpose described.

A filling wire head is employed for feeding the filling wire, the drive for which consists of a small D.C. back-geared motor, with a shunt regulator for accurately adjusting the feeding speed of the filling wire, which is fed from a bobbin with a nozzle and transport rollers. The nozzle is arranged, so that it can be adjusted in a tube and the wire feed can be interrupted by a lever. The filling wire head is so mounted, that it can be rotated on a tube, and it can also be moved transversely in the direction of welding. All switches, regulating and measuring instruments are mounted on a separate control board.

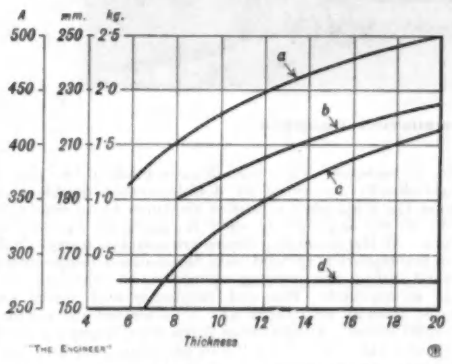
Two typical examples of automatic carbon arc welding plant are shown in Figs. 3 and 4, the former being a stationary plant for mass production of tubes composed of sheeting of about 8 mm. to 15 mm. thickness, with welded longitudinal seams. A is the feed magazine and B the outlet for the welded tubes, the welding head being stationary, whilst the tubes are moved automatically underneath it. The automatic welding equipment shown



A—Welding carriage.
B—Bridge.
C—Pillar.
D—Welding head gear.
E—Cross-support.
F—Adjusting wheel to E.
G—Carbon welding head.
H—Filling wire welding head.
J—Filling wire bobbin.
K—Paper-strand bobbin.
L—Ammeter and voltmeter.
M—Switching in and out push-buttons.
N—Travel regulator for A.
O—Travel regulator for B.
P—Feed regulator for filling wire.
Q—Automatic cut-outs.
R—Auxiliary switch.
S—Toothed rack.
T—Fan for removing welding vapours.

FIG. 4—UNIVERSAL WELDER

in Fig. 4 is a universal equipment for workshops turning out various kinds of work. When the carriage A is placed on the bridge B, which is arranged to move crosswise, the head can be moved in a vertical, longitudinal and transverse direction. The vertical adjustment can be obtained by raising and lowering the pillar C, which is provided with a tooth rack S. The welding head gear at D mounted in a rotatable manner at the lower end of the pillar, comprises the following equipment—the cross support E with adjusting wheel F, carrying the carbon welding head G; the auxiliary head H with the bobbins J and K for the wire and paper respectively; the instruments L for measuring the current and voltage; the push buttons M for controlling the two contactors on the control panel; the regulators N O P for adjusting the travelling speed of the welding carriage;



a—Consumption of filling wire per hour in kilogrammes.
b—Welding current in amperes.
c—Consumption of carbon per hour in mm.
d—Consumption of paper strand per hour in kilogrammes.

FIG. 5—CONSUMPTION CURVES

the bridge and the feeding speed of the filling welding wire; the automatic cut-outs Q for protecting the various circuits, and the various auxiliary switches R. The pillar C with the tooth rack S for raising and lowering the head, also serves as a chimney for removing the vapour at the weld, and at the top there is a fan T. The carriage A, which has two axles running in ball bearings, accommodates the hoisting gear and lowering brake, and a circulating water pump. The incoming current supply to the various circuits is established by collectors, arranged as shown in the illustration.

The capacity of the carbon arc expressed in terms of the number of metres welded per hour is said to be from two to three times greater than that of the metal arc process, the cost of which is more than double that of the carbon method. This refers to the actual welding time, all secondary costs, such as setting up the seam, aligning, &c., being neglected. Frequently the time required for these operations is very much longer than the actual welding time, a fact which is also claimed to make carbon arc welding advantageous, as laborious preparation of the seam, aligning, and insertion and removal of clamping devices are eliminated. The consumption of material with carbon arc welding is shown as a function of sheet thickness varying from 6 mm. to 20 mm. in Fig. 5. Apart from the paper consumption, which is independent of the thickness of the metal, the other consumption items increase approximately with the thickness.

The machines described are made by the A.E.G. Electric Company, Ltd., of 131, Victoria-street, Westminster, S.W. 1.

SIXTY YEARS AGO.

OUR issues of bygone years are of interest to-day, not only for the records which they give of what was achieved, but for the information which they contain concerning schemes that were proposed but never carried out or accomplished only after the lapse of many years. Much, for instance, is to be found in our columns sixty years ago about diverse plans for bridging or tunnelling the English Channel or for establishing a train ferry service across it. Another favourite scheme which was to remain unfulfilled was the construction of an overhead line of railway to connect Charing Cross Station with Euston and the other termini serving the North. Of less importance, but still interesting, was a proposal, mentioned in our issue of May 3rd, 1872, to bring the luxury of fresh sea water baths to the inhabitants of the West End of London by pumping from the sea at Brighton to the summit of the South Downs, whence the water would gravitate through enamelled pipes to the Metropolis. That scheme was embodied in a Bill, described as virtually unopposed, which was then before Parliament. The railways were, however, the chief source of schemes which were to remain unfulfilled or to be carried out long after they were first proposed. In the issue referred to we note a report to the effect that rumours were in circulation concerning the Government's intention to purchase all the railways in Ireland, and that as a consequence there had been great activity in Irish railway stocks. Grave concern was expressed lest the spreading of similar rumours regarding English railways would lead to a sudden and upsetting outburst of rampant speculation. If these schemes were founded merely on rumour, there was nothing of that nature in certain others relating to the country's railways which were then occupying a place in men's minds. Railway amalgamation had passed beyond the stage of unofficial discussion, and had reached the Parliamentary Bill condition. Opposition to it was widespread. Manchester, Plymouth, Gloucester, Southampton, Dundee, and many other towns expressed themselves strongly against it. Southampton was, in particular, opposed to any kind of traffic agreement between the Great Western and South-Western railways. Both these companies, it was alleged, had treated the town with neglect and tyranny. The traders greatly desired the Midland Company to extend its line to the port, the business of which was suffering badly from the lack of attention paid to it by the existing railway companies. Dundee was alarmed about the proposed amalgamation of the Caledonian and North British lines. It had already experienced a foretaste of what it might expect from such a step in the rise of rates which had followed the amalgamation of the Caledonian and Scottish North-Eastern companies. Great hopes were placed on the completion of the Tay Bridge and the increase of competition which, it was argued, it would bring. It was contended that if amalgamation were permitted the completion of that bridge would probably be abandoned. Neither of these specific schemes of amalgamation, it will be noted, are included in the railway groupings of to-day. Southampton, under the fostering care of the old South-Western and the Southern companies, has, in spite of its former inhabitants' fears, become one of the chief ports of the Empire. Dundee got its bridge and was pleased with it—until the disastrous night in December, 1879.

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

BRAIDED CABLES.

No. 446—1932. The use of braided conductors for overhead lines is the exception rather than the rule, and the object of this specification is primarily to assist British manufacturers in their export trade, more particularly with New Zealand, in which country the use of braided cable is compulsory in certain circumstances. Users in New Zealand have in the past been unable to rely on the product being uniformly good, owing to the lack of a British Standard Specification, and with a view to securing an improvement in the position by the elimination of the "competitive" grades, the New Zealand Electric Supply Authority Engineers' Association requested the British Standards Institution to prepare a specification, the adoption of which will probably ultimately be made compulsory in New Zealand.

Although the use of braided cable in New Zealand has been stressed above, this class of conductor is also used in other parts of the Empire to a certain extent. The points covered by the specificaton include the mechanical and electrical properties of the copper conductors and the quality and dimensions of the braiding.

SCHOLARSHIPS.—The Manchester City Council is again offering a number of scholarships tenable in the Faculty of Technology of the University of Manchester. Successful candidates are required to follow a full-time course leading to the degree of Bachelor of Technical Science in the College of Technology and Matriculation or its equivalent is an essential qualification. For students who have been engaged in industry and who have attended part-time day or evening classes the scholarships are of the value of £100 per annum, while for students leaving secondary or central schools the value is £60. Both classes of scholarships are tenable for three years.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The New Tariffs.

THOUGH widely differing views are held in Midland engineering, iron, and steel, and manufacturing circles on the new tariffs, the bulk of opinion seems favourable, but it does not rise to enthusiasm. The increased protection, where afforded, and the intimation that it is not proposed to grant any reductions for twelve months at least, should inspire manufacturers with confidence and stimulate industrial development. In those instances where the Abnormal Imports Duties have applied and the new tariffs are less protective, some concern as to the future is felt, and in instances, such as the pottery trade, efforts are being made to secure redress from what is claimed to be a genuine grievance. The protection afforded iron and steel is considered insufficient to keep out foreign material, and it is naturally claimed by some consumers of foreign semis that the result will be detrimental, in that it will increase costs of production and prevent them successfully competing with the finished product. It is, of course, realised that only the first word has yet been said as regards iron and steel tariffs. Iron and steel, partly because they are the raw materials of so many industries, and partly on account of the abnormal severity of foreign competition in respect of semis, present a difficult problem. The present duty is of a temporary character, and is to apply only until the special problems of the industry can be more closely examined. Midland iron and steel masters appear to have no doubt but that the intention of the Advisory Committee is to propose ultimately rates of duty which shall serve a definitely protectionist purpose. That is their deduction drawn from the Committee's references to "abnormal importations at very low prices" and to "the necessity for maintaining a prosperous iron and steel industry in a high degree of efficiency." The 33⅓ per cent. is not all supporters of the policy desire, but they are satisfied that at least they are now being given some chance to compete against dumped goods. It is predicted here that the three months' duration of the flat rate on semi-finished steel will have to be prolonged somewhat to enable inquiries to be concluded. Generally speaking, then, in the iron and steel industry the new tariffs are welcomed as a first instalment, and it is considered they will prove generally beneficial.

Local Manufacturers' Prospect.

Anxiety as to the effect of the tariffs is expressed by many Black Country manufacturers, and complaint is prevalent in some industries, such as the hollow-ware trade, that the duties are too low. In the chain and anchor trade, while benefit is anticipated in some sections, in others an adverse effect is expected. Firms which manufacture best-quality chain for mines and railways are stated not to be affected, as only English iron is used. As far as small sizes of chain are concerned, benefit may be derived, but an opposite effect may be felt by some sections of the cable and anchor industries. In the tube trade, it is asserted that increased cost of production will make it particularly difficult for tubes to be sold abroad. A number of nut and bolt manufacturers in the Darlaston area consider that they should have equal protection to steel. The new duties may handicap export trade. One producer of bolts and nuts points out that Continental steel will still be £1 a ton cheaper than present British prices, and it will accordingly be bought. The view expressed by a constructional engineering firm is that the tariff on imported steel is a good thing, because it puts all firms on the same footing. Hitherto, one never knew, said an official of the firm, if a competitor was quoting on British or foreign steel. Colonel J. S. Trinham, President of the Birmingham Exchange, gave it as his personal opinion that manufacturers of railway products were to have an inadequate protective duty. He thought, however, manufacturers could rely on the patriotism of the railways to support home manufacturers. The protection given to rivets, bolts, and nuts, as well as to anchors and ship's cables, appears to be totally inadequate. The new tariffs, however, generally speaking, are welcome. Mr. M. F. Scarf, of the Bromford Iron Company, Ltd., objects to the duty not being graded. It is the same on billets as on finished material, and may therefore be a direct inducement to the foreigner to send his material, not in the form of the unfinished product which would find employment for men here, but as the finished article. Another Midland industrialist claimed that the new duties would not help the re-rollers or the makers of steel, for they would not prevent foreign steel from coming into the country. Glass makers are disappointed in that for them there is a drop of 30 per cent., the Abnormal Import Duty having given place to the new duty of 20 per cent. Toy-makers are pleased and anticipate greatly increased employment, alike for themselves and allied trades, including the manufacturers of stampings and small electrical fittings. The hollow-ware trade says that the foreigner can afford to ignore a 20 per cent. tariff, and that a 50 per cent. duty is needed to be effective. The electrical and the jewellery trades both expect to benefit, as do the leather trades.

Potters' Appeal.

The English pottery trade which under the operation of the Abnormal Import Duty of 50 per cent. was beginning to revive, regards with grave apprehension the reduction of the import duty on foreign pottery to 20 per cent., which, it is claimed, will be inadequate to keep out the foreigner. The late duty practically cut out the foreigner from the British market, and as stocks of foreign pottery were decreasing, potters in this area were coming into their own. Already there are reports of foreign importers preparing to flood the market with foreign pottery, especially of German and Czechoslovakian origin, and anxiety in the Potteries is so acute that the Manufacturers' Federation has lost no time in placing the views of the industry before the Tariffs Advisory Committee. It now anxiously awaits the outcome of its representations for reconsideration of its case.

New Steel Works.

A new steel works is being erected at Sandbeds, Short Heath, by Starkey and Hawker, of Hall-street, Willenhall, to manufacture steel hitherto imported from abroad. The firm has been a large importer of bright strip, but on account of the new tariff it has decided to produce its own. It is stated on behalf of the firm that it will be able to produce steel at a cheaper figure than Continental manufacturers can to-day, and that the firm's output will be all-British and equal to the highest quality. It is hoped to produce about 50 tons of steel weekly and to open the works in about six weeks' time. A new company will be formed under the style of Ductile Steels, Ltd., to take over the firm of Starkey and Hawker, although that branch and another branch at Smethwick will be continued. The works equipment will be all-British, and will include the latest type of cold rolling plant. A site covering 2 acres has been secured, and it is hoped in the near future to enlarge the works. It is reported by the firm that sufficient orders had been received to keep the works busy for the first three months.

New Type of Pit Prop.

A new type of steel prop has just been subjected to severe tests in a Cannock coal mine, and has come through so well that arrangements have been made for its manufacture on a substantial scale. The prop, which is known as the Cannock Safety Prop, is the invention of Mr. Reginald Whitehouse, of C. Whitehouse and Sons, Bridgetown. The prop has a collapsible top, the catch which releases it being operated by the miner at an ample safety distance. The prop is easily dislodged from one section of the roof and transferred for use elsewhere. It is tubular in shape, is made of malleable metal, will bend before it will break, and its weight is only 47 lb. for the 4ft. 6in. size. The prop combines efficiency and lightness of structure, and is likely therefore to commend itself to the miner. The Mines Research Department has given its approval to the invention.

Market Position.

There is a better tone generally in iron and steel and engineering circles in the Midlands and Staffordshire, but the market has not yet settled down to the new conditions brought about by the Government's protective policy. Manufacturers report slow but steady improvement in business, but they are not just now in need of fresh supplies of material. The business transacted on 'Change in Birmingham this week was about on a par with recent weeks, and for the most part was negotiated at the price levels ruling of late. Buying is at a low ebb, and tonnages are meagre. Better times are now, however, confidently anticipated.

Steel Prices.

Selling prices of finished steel have been reaffirmed, but as no definite period was given for their operation it is assumed that the scale may be revised at any time should the situation justify the Manufacturers' Association meeting specially to reconsider the position in the light of any new developments which may arise as the result of the Government's protective policy. Specifications for heavy steel are not sufficient to keep the mills working regularly. There is a dearth of orders from constructional engineers, owing to the quietness in the building industry. Bright cold rolled steel continues in fairly good demand. Various high-grade steels show a stiffening tendency. There appears to be no anxiety to secure forward supplies, and small tonnage orders are the rule. In the half-products branches, values are firm, and native billets have recovered somewhat, the general quotation at date being £5 7s. 6d. Small steel bars re-rolled from Continental raw material continue to be quoted £6 7s. 6d., and all-British bars £7 5s. upwards. Sheet bars are £5 to £5 5s., and Staffordshire hoops £9 10s. Foreign competition is at the moment negligible.

Steel Scrap.

Merchants who sell steel scrap find it extremely difficult to carry on business. All the works in this area are limiting deliveries as far as possible against existing contracts, neither is there any improvement in the demand from South Wales. Prices are unremunerative.

Pig Iron.

There is little change in the volume of demand for forge and foundry grade pig iron, and deliveries against contracts account for only part of the production from the furnaces in Northamptonshire and Derbyshire, although only a small number of plants are active. Blast-furnacemen are watching the position very closely, for if it develops as many anticipate there may be increased calls made upon them. Basic pig has been coming into this country from the Continent in appreciable quantities. Foundrymen in this area realise that if imports are seriously impeded, while at the same time demand for half-products and finished steel is diverted from the foreigner to the British producer, blast-furnace materials may become tight. Some foundrymen are considering the advisability of increasing their commitments of pig iron as an insurance against such a development. Stocks of raw iron at the furnaces are said to be adequate to meet quite an appreciable extension of demand. Values are firm and unchanged. Derbyshire and North Staffordshire No. 3 foundry is £3 6s., forge £3 1s., Northamptonshire No. 3 foundry £3 2s. 6d., forge £2 17s. 6d., all per ton delivered Black Country stations.

Finished Iron.

The finished iron trade of Staffordshire shows no improvement. Marked bar makers are seeking orders so that mills may be kept rolling, and other branches are only partially employed. Prices stand at £12 for best bars, £9 2s. 6d. upward for Crown iron, £8 7s. 6d. for nut and bolt and fencing bars, and £10 10s. for wrought iron tube strip. It is unlikely that the entry of Continental No. 3 iron used by the Black Country bolt and nut works will be seriously affected by the new tariffs. The difference in price, even with the full duty added, leaves little chance for the local ironmaster successfully to wrest the business from his foreign rivals.

Galvanised Sheets.

Despite some improved inquiry and demand from overseas markets for galvanised sheets, selling prices remain unsteady. This week there has been a greater tendency for the level to stand at £9 5s. for 24 gauge sheets. Few mills quoted the higher standard of £9 7s. 6d. Competition for business was keen, local mills being but poorly employed.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Increased Duties.

POLITICAL bias in relation to the tariff question, even in this part of the country, is almost an unknown quantity these days, and the increase in the duties has been discussed almost wholly from an economic point of view. Expectations had been centred largely upon higher duties for iron and steel products, and the more general increase in tariff rates announced last week-end created a good deal of surprise. On the question of iron and steel, naturally, the viewpoint varies according to whether the interests involved are those of the producer or the consumer. Leaders of the Lancashire iron and steel-producing industry who have expressed opinions are pretty well unanimous in the belief that much good will result, although it is generally recognised that some time must necessarily elapse in consequence of the heavy stocks of imported materials that are held in the district as in most parts of the country. On the other hand, there is the view that the increase in the tariff rates is hardly sufficient to make any effective difference in the competitive position of British and foreign iron and steel products, and there is also the opinion of the large users of imported materials, to say nothing of the merchants and stockholders, who seem likely to have to pay something like an all-round £1 a ton extra for their raw materials, which, however, will still be about £2 a ton below the cost of the corresponding British goods. The extra duty to be paid on imported machinery, castings and forgings is expected to have a beneficial effect on a number of Lancashire industries, and possibly, also, upon the industries concerned in supplying the materials involved in their manufacture. Above all, however, there is in evidence a note of caution, for it is recognised that whilst tariffs may be a means to an end, it is order books that will prove to be the ultimate test.

Liverpool Developments.

Two important Liverpool dock improvement schemes were formally inaugurated by the Lady Mayoress, Mrs. J. C. Cross, last Friday. These were the new 700-ton rolling bascule bridge connecting the Salisbury Dock and the Trafalgar Dock, and the Trafalgar Dock itself. Mr. Richard D. Holt, chairman of the Mersey Docks and Harbour Board, in a statement after the opening ceremony, explained that both developments had been made possible by the establishment of a municipal electric power station at the old Clarence Dock, which was constructed as long ago as 1830. An interesting incidental statement was that the new bridge could be lowered at a cost of a halfpenny and that the structure was so well balanced that it could be raised again at a cost of a halfpenny. The new Trafalgar Dock and the graving dock basin have an area of more than 7 acres, and the new transit sheds alongside the dock a length of 2195ft. and a floor area of 13,316 square yards.

A New Mersey Dredger.

An order for a new sand pump dredger has just been placed by the Mersey Docks and Harbour Board with Cammell, Laird and Co., Ltd., Birkenhead. The new vessel will have a capacity of about 3500 tons, and the contract price is £103,000.

Non-ferrous Metals.

Following upon last week's general recovery of prices in the non-ferrous metals market, there has been a further upward movement in all sections, tin being the chief centre of attraction and the metal to be principally affected by the rise. The underlying factors influencing the recovery in the case of tin have been the decision of producers to impose further drastic reductions in the output and a slight change for the better in the statistical outlook. The result was a decided swing of prices towards higher levels, the week's recovery of nearly £10 per ton having brought quotations to very little below where they were about the end of March. Whether this firm tendency will continue to any appreciable extent remains to be seen, but it has been evident that users are taking no risks and some expansion of the demand for the metal has been seen. Although copper is some 12s. 6d. to 15s. per ton dearer on balance, the outlook is the reverse of encouraging. Stocks of the metal show no sign of attaining more reasonable dimensions in relation to the demand, and buying interest, including a moderate inquiry from cable-makers, has been distinctly sluggish. Sales of lead have likewise been quiet, but with offerings rather more restricted, prices have gained about 5s. per ton on the week. The demand for spelter from the home consuming industries has been quiet, but supplies in this case also are somewhat less freely offered and current values represent a rise compared with last report of nearly 10s. per ton.

Iron and Steel.

Except that some Midland foundry iron makers have been able to report a slight improvement in contract sales to users in this area, there has been no apparent

change for the better in general conditions in the iron and steel-consuming industries. The tariff increases have had no influence on the demand so far, and it is recognised that it may be necessary to wait for some time before the effects become evident. The light castings industry is only moderately engaged and unsatisfactory conditions generally are reported in respect of the heavy foundry branches, and also of the jobbing foundries. The consequence is that deliveries into consumption are no better than before, the additional buying referred to being merely in the nature of contracts to replace some expiring. Derbyshire, Staffordshire and Cleveland No. 3 are all quoted for delivery equal to Manchester at 67s. per ton, with Northamptonshire at 65s. 6d., Scottish at about 86s. 6d., and West Coast hematite at 81s. The demand for finished iron is as poor as ever, but values are maintained at £9 15s. per ton for Lancashire Crown quality material, and £10 5s. for best bars. Local inquiry in the steel market shows no expansion, and both for the heavy varieties and for special alloy steels orders this week have been few and for very restricted quantities; but, so far as prices are concerned, these are on the old levels. Business in imported materials is of little consequence, with quotations nominally about £1 higher all round as the result of the increased duties. For delivery to works in the Manchester district, Continental billets and sheet bars are at about £5 per ton, Thomas plates at £6 12s. 6d. to £6 15s., Siemens plates at £7 15s., joists at £5 12s. 6d., steel bars and angles at £5 15s., and No. 3 Belgian iron at £6 15s.

BARROW-IN-FURNESS.

Hematite.

There have been no developments during the week, and the hematite pig iron trade remains quiet. At works where production has ceased stocks are coming down gradually, but not as fast as makers desire, by a long way. There is little if any iron being used on steel account locally and the prospect of rail departments requiring steel to any great extent in the early future is remote. Business with the Continent has improved slightly, but there is much room for improvement in this trade yet. American business is still lacking. Evidently, the American requirements are small at present, otherwise buyers would be tempted at present prices as effected by the rate of exchange. The iron ore trade continues to be very dull, which is not to be wondered at considering the few furnaces in blast. The steel market continues to be very quiet, and there are few orders in the market, or likely to be. Barrow may restart in the early future, but at the moment the date has not been fixed. Shipments of steel are almost nil, excepting hoops, for which there is a moderate demand. Last week a cargo of steel billets arrived at Barrow from Belgium. The shipping trade is very quiet, and business in steam coal and East Coast coke is not brisk.

SHEFFIELD.

(From our own Correspondent.)

General Position Slightly Better.

Owing to decreased buying from shipyards and railway plants, among other things, the depression in the heavy steel sections remains very acute, but the general position of the city's industries is a little better. Makers of certain types of tools are booking increased orders and are very hopeful as to the future. The reason is that stocks of foreign tools are becoming depleted, and future supplies will have to come from home factories, which will be called upon to produce in increasing quantities. While table cutlery and ordinary lines of plate continue in a bad state, some substantial contracts for gift and other special purposes are on hand, and additional operatives are being engaged at some of the cutlery, plate, and tool works. There is a fairly large volume of work being done for the motor industry, and stainless steel and cold wrought strip are more active now than they have been for some time. The dismantling of Vickers' works in connection with the reconstruction scheme is proceeding rapidly. All the eight or nine Siemen's steel furnaces, except a special one, have disappeared, as well as the smaller furnaces in the melting house. Large chimneys have been felled and a surprising clearance has been made.

Less Unemployment.

An indication of the upward tendency in trade is shown in the substantial reduction in the number of local unemployed. The total, while still very considerable, is nearly 1000 less than at the Easter holiday stoppage. This is due chiefly to numbers of half-timers going on full time, particularly in the tool and certain branches of the cutlery trades. There is little change for the better in the heavy steel departments.

A German Venture.

The action of the German Government in placing a prohibitive tariff on the export of used machinery, following the embargo on the export of capital from Germany, is affecting a German cutlery firm which is equipping a factory in Sheffield. The firm brought in a considerable portion of plant required before the duty came into operation. The other portion remains in Germany. Meanwhile, it is not known what the next steps will be in regard to the project.

New Tariffs' Disappointment.

The anticipated effects of the protection of local industries are not pleasing Sheffield cutlery manufacturers, who take the view that a 20 per cent. tariff is not large enough to meet foreign competition. The fact that ferro-alloys have not been subjected to abnormal duty is appreciated by steel manufacturers, but makers of safety razor blades and hack-saw blades are very disappointed that the duty is only 20 per cent. The safety razor-blade manufacturers contend that 20 per cent. is totally inadequate, and that they cannot possibly put down plant to compete with the cheaper blades which are coming in unless they have security for a greater period than a year.

Boston Sluice Danger.

An inundation by the sea over thousands of acres of land in Eastern England is foreshadowed if the Grand Sluice at Boston gives way. Mr. R. S. Godfrey, surveyor and clerk of works of Lincoln Cathedral, in a report to the Witham and Steeping Rivers Catchment Board, says that the sluice is in a serious condition, and no longer an invicible barrier between land and sea. Mr. Godfrey points out that the tide at Boston has a rise at times of about 26ft., but the fall in the river Witham between Lincoln and Boston is, by comparison, almost negligible. The Board has placed the contract for the repair work in the hands of John Thompson and Co., of Peterborough, and it is estimated that it will take nearly two years to complete. The Grand Sluice was built in 1766. On inspecting it recently it was discovered that the brickwork on the piers on both land and sea sides, especially on the latter, was disintegrating rapidly. In other parts the brickwork was bulging, and these parts, if struck with a hammer, gave a sure indication of hollowness. A certain amount of settlement had taken place in the superstructure, the face of which was more or less split from the core. On the sea side of one of the piers there was a horizontal crack and the bricks themselves had split almost in a straight line. The grooves of birch, which were constructed specially for timber damming of each of the locks, were more or less split vertically the whole height in both sides of the grooves. Should these be subjected to the full water pressure in the near future, there was every possibility of a collapse. Although nothing had as yet taken place to hinder the free movement of the gates, it should not be taken for granted that they would keep intact indefinitely. Mr. Godfrey advised the Board to limit vehicular traffic until the repairs were completed to 5 tons, the speed not to exceed 5 miles an hour, in order to avoid, if possible, any collapse.

Humber Bridge Scheme.

The Minister of Transport has informed the Hull Corporation and Lindsey County Council, joint promoters of the Humber Bridge Bill, that he cannot bind the Government to give financial assistance to the scheme, but that this ruling does not imply that the possibility of a grant at a later date is precluded. The proposed bridge is estimated to cost approximately £1,750,000. The preamble of the parliamentary bill was proved before the House of Commons Committee in the last Parliament, and a Government grant equivalent to 75 per cent. of the cost of the bridge was promised by the late Government. It is understood that the financial aspect of the Bill is fundamentally changed by the Minister's statement, and the promoters are now considering a tentative suggestion that the bridge scheme might be financed by tolls over an extended period without the assistance of the Road Fund.

Doncaster Waterways Project.

The Sheffield and South Yorkshire Navigation Company has reached an agreement with the Doncaster Corporation, which is likely to have far-reaching results. Briefly, it is proposed to construct a new cut from a point opposite the new Technical College at Doncaster in a northerly direction to a point near the new railway bridge which serves the Corporation's Wheatley Park estate. An entirely new wharf and warehouse, capable of extension, will be constructed on Greyfriars-road. The existing wharf and warehouse, together with certain lands, will be transferred by the Navigation Company to the Corporation. The old course of the canal between these points will be filled in. The new wharf will have excellent access immediately adjoining the centre of the town, and be much more commodious than the present accommodation. The whole scheme is estimated to cost in the neighbourhood of £24,000, and the commencement now only awaits the sanction of the Ministry of Health. The work is likely to be completed in about twelve months.

Stainless Steel Reinforcing.

The masonry of the Church of the Holy Sepulchre at Jerusalem is to be reinforced by Sheffield stainless steel. Brown, Bayley's Steel Works, Ltd., have been entrusted by the Crown Agents for the Colonies with the fabrication of a series of stainless steel bands which will reinforce the masonry. The dome of this church, which was originally built by the Crusaders, has been rocked by earthquakes three times in its history, and is now considered unsafe. The reinforcement will consist of five bands, the largest of which passes round the drum at the base of the dome, and has a circumference of 120ft. The other four bands are tied into the masonry of the dome itself, and are of gradually diminishing circumference. Each band consists of eight sections joined with double butt straps, and will be assembled with stainless steel bolts. The cross section of each member of the largest band will be 5in. by 1in., and the cross section of the bands in the dome itself will be 3½in. by 1in. The whole will be constructed from Brown Bayley's "Twoscore" stainless steel, which has been previously used for similar important reinforcements, notably that of the dome and peristyle of St. Paul's Cathedral.

NORTH OF ENGLAND.

(From our own Correspondent.)

Indications of Better Trade.

The outlook for industry in the North of England is decidedly brighter. Cheaper money and the new steel tariffs are both bull points. Already there are some indications of a probable improvement in the conditions of the iron and steel industry. It may not be to a marked extent, but it will be something if there is a change from the depressing state which has been experienced for many months past. The increased tariff duty on the imports of steel is welcomed by the trade, but the experimental period of three months does not seem to meet with much favour. The fact must not be overlooked that when a tariff duty was first threatened there was a rush to dump material into the country, and stocks held at the moment are on a heavy scale. These will have to be reduced before new orders are freely distributed. But the volume of imports from abroad has for years past been so substantial that their limitation will necessarily divert a big volume of business to British works. Pig iron continues to enjoy no more than the 10 per cent. duty, but, coupled with the fall in the value of sterling, this has been effective in excluding imports of foreign pig iron in this area, though Scotland—at one time Cleveland's largest home customer—continues to buy Indian iron, which comes in duty free. Still, in three months aggregate imports of pig iron have totalled 48,184 tons, compared with 66,958 tons in the first three months of 1931, and it is held that there is a case also for a higher duty on pig iron. In any event, expansion of demand for pig iron is assured as activities at the steel works increase, and foundrymen also anticipate busier times.

Cleveland Iron Trade.

Recent events have imparted a more optimistic tone to the Cleveland pig iron trade. Some regret is expressed that the additional tariff does not extend to pig iron, but Teesside has virtually ceased to import foreign iron. By cutting prices, Cleveland makers have sold some substantial parcels in Scotland, and are now disposing of the whole of their output. In some cases stocks are being drawn upon to meet commitments. Foreign sales are few, as Cleveland prices are not competitive abroad. No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge, 57s.

Hemstite Pig Iron.

Demand for East Coast hematite pig iron shows a little expansion. Small parcels continue to be sold with marked regularity, but the amount of buying for forward delivery is very small indeed. The present demand is just about sufficient to absorb the current limited output. Producers are inclined to take a firmer stand, and the minimum price of mixed numbers is now 63s. 6d., with No. 1 quality at a premium of 6d. per ton.

Ironmaking Materials.

The foreign ore trade continues exceedingly quiet. Consumers continue to be disinclined to negotiate for supplies. Moreover, they have large stocks and deliveries to take under running contracts. Best Rubio ore is nominal at 15s. 6d. c.i.f. Tees. Blast-furnace coke is in slow demand at 15s. 6d. to 16s., delivered at works.

Manufactured Iron and Steel.

A more hopeful spirit pervades the manufactured iron and steel trade, and there is every appearance that the worst is passed. Little forward buying interest has developed yet, and the business that is being done is chiefly limited to small tonnages over short periods. Some little time must elapse, of course, before any appreciable effect is felt from the imposition of the increased tariff duty, particularly in the case of semi-manufactured steel, such as billets, blooms, sheet bars, &c. Stocks of foreign products are understood to be fairly heavy, and will take some months to liquidate. Constructional engineers are placing a moderate weight of business, and inquiry for railway requisites has improved, but there is very little doing in shipbuilding material. All prices remain unchanged.

The Coal Trade.

The outlook in the Northern coal trade remains disappointing. The demand under old contracts for early delivery remains at minimum commitments for every grade. Home demands generally give not the slightest sign of expansion, and exports, under severe import restrictions into France and Germany, hold trade in abeyance. Pits continue to work irregularly in Durham, and the position is not bright in Northumberland at the moment. Prices, however, are maintained for prompt shipment, and early May. Northumberland large steam coals are steady at 13s. 6d., but small coal is abundant and easy in tone at 8s. 6d. Special Durham steams are firm, as production is kept down to definite orders, sellers asking 15s. for large and 12s. for small. Tyne prime steams are quiet, but on the whole steady at 12s. 9d. to 13s., with small firm at 9s. Hastings are quoted at 12s. 6d., but other secondary steam are in good supply at 12s. to 12s. 3d. This class of small is plentiful at 8s. There is no scarcity of supply in any description of Durham coal, but for the favourite brands of bunker coal bookings are fairly satisfactory, with prices well held at 13s. 6d. to 13s. 9d. Good secondary qualities can be obtained at 13s. Best class gas coal is fully steady at 14s. 6d. and Wear special qualities at 15s., but secondary gas are pressing on the market at 13s. 3d. to 13s. 6d., while the outlook for coking coal is not bright, any good brand being quoted round about the fixed minimum. Prices range from 12s. to 13s. 9d. Gas coke is holding steady and daily output is taken up. Stocks are in good volume, but the continued cold weather keeps the home consumptive demand up to the recent level, and 18s. is asked for May deliveries. Patent oven coke stocks are ample, and prices remain easy at 14s. 6d. to 15s.

SCOTLAND.

(From our own Correspondent.)

Steel.

There is no change of importance in the Scottish steel trade. The demand for heavy steel in particular is most unsatisfactory, bookings becoming more and more restricted, owing, in a measure, to the diminishing output at the shipyards. The inquiry for sheets is comparatively

good, and although firm business is slow at the moment, an early expansion is anticipated. Thin sheets are most in evidence, heavy sheets being poorly specified. Galvanised descriptions are comparatively quiet. There is a fair inquiry for tubes, which, it is hoped, may bear fruit. Steel sheet re-rollers who have hitherto depended on cheap Continental sheet bars for their raw materials, will have their costs substantially increased under the new tariff duties, and will, as a result, be handicapped in their competition for export business, which, as a rule, accounts for a large proportion of their output. While steelmakers are probably not satisfied with the amount of protection granted in respect to finished materials, they will probably be glad of the opportunity afforded them to supply sheet makers and bar re-rollers with their raw materials at competitive prices.

Iron.

The bar iron trade still lacks any sign of improvement. Seasonal demands are slow to materialise and the general state of the inquiry is not encouraging. So far as producers of re-rolled steel bars are concerned, it appears probable that they only view with a certain amount of dismay that they will have to compete with finished bars at £4 4s. per ton with their raw materials costing practically the same price.

Pig Iron.

Supplies of Scottish pig iron are still more than equal to the demand, with the number of furnaces in blast remaining at six. Competition continues keen, cargoes still arriving from India and England. Last week 500 tons from England were unloaded at Bowling.

Scrap.

Dealings in scrap material have been tight, and prices show a weaker tendency, with cast iron machinery at 47s. 6d. to 50s. per ton, and heavy steel about 37s. 6d. per ton.

Coal.

Shipments of Scottish coal during the past week showed an increase at 255,795 tons, compared with 233,221 tons in the preceding week, and 208,831 tons in the same week last year. Export business continues very quiet, however, the bulk of the shipments being against old contracts. Up to date the decrease in shipments compared with the same period last year amounts to 500,791 tons. The dearth of export business and decreasing home demands have caused supplies of most fuels to become fairly plentiful. Fifeshire treble nuts are moving freely, but doubles and singles in all districts are available for export at about the minimum prices. Outputs are being curtailed further, especially in the Lanarkshire area. At present the general demand for home and export is mainly confined to small immediate deliveries.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Industry.

THE influential deputation from South Wales which met Mr. Baldwin, Lord President of the Council, at Whitehall on Thursday last week to present their case for the use of coal in place of oil for naval vessels, had a very sympathetic reception, and Mr. Baldwin confessed that he had never met a stronger deputation or one which presented its case with more earnestness. He promised to lay the views of the deputation before the Prime Minister as soon as the latter returned from abroad. The deputation pressed for the appointment of a Commission of Inquiry, every aspect of the question being dealt with by various members of the deputation. It must, however, be a considerable time before this meeting yields any result of a tangible character of benefit to the steam coal industry. Meanwhile, the position would almost appear to be becoming more involved and difficult than ever, when the international situation is reviewed. Certainly, no news has come to hand to clarify the outlook, or make things easier for the coal export trade of South Wales. Poland is taking further steps to strengthen its coal export operations, Germany is, in effect, reducing her railway rates on German coal from pithead to the land frontiers in order to secure a bigger volume of European trade, and France is reported to be contemplating an additional restriction upon coal imports. All sorts of rumours have been in circulation to the effect that imports were to be cut down to 50 per cent. of the average monthly quantities of the three years 1928–30, while even as low as 40 per cent. has been mentioned; but the latest information from Paris is that nothing has so far been decided, though there can be no doubt that the question of a further reduction in coal imports is under consideration by the French Government. To turn to the anthracite section of the industry it is satisfactory to find that shipment operations are continuing briskly; but the latest news from America is not at all cheering, as it is announced the Senate Finance Committee has voted to retain the duty of 2 dollars per ton on coal which was recently passed by the House of Representatives. On the basis of the present rate of exchange this means a tax on coal imports of about 10s. per ton. So far no date is indicated as to when the proposed tax is to operate, but when it does come into force it will prove a very serious obstacle to further shipments from South Wales.

Coal Export Operations.

The present position in regard to coal shipments cannot be regarded as at all satisfactory, excepting, of course, the anthracite section. Loading operations at Swansea are still brisk, and there is tonnage waiting to load. On Tuesday of this week the number of waiting vessels was six, but when one turns to the other ports in the Channel, where steam coals are mainly shipped, the situation is rather depressing. At the end of last week there were forty-four vacant loading berths, and on Monday, as the result of week-end arrivals, this figure was reduced to thirty-two; but by Tuesday the number was back to forty-two. It will be seen from this that the position of steam coal collieries is a very weak one and many temporary stoppages of work are inevitable with such a lack of facilities for releasing wagons. Business in all directions remains as quiet as ever, both for prompt and backward shipment. In the case of contract business it is confirmed that the order for about 300,000 tons of sized coals for the Buenos Aires Electricity Works for delivery at Buenos Aires over 1933 has been divided between South Wales and Germany. Unfortunately, Germany has secured the greater part of the contract, as it is stated that a leading local firm has obtained between 110,000 and 120,000 tons. The report is current that an associated undertaking of the Buenos Aires Electricity Works at Rosario is coming in the market for about 100,000 tons of sized coals for delivery over 1933 at Rosario. So far as can be ascertained no other contract business of importance is under negotiation at the moment, the inquiry from all quarters being very restricted. As regards shipments of steam and anthracite coals from the leading ports under the control of the G.W.R. Company, returns for last week show that the total was only 400,625 tons, which compares with 446,365 tons for the preceding week, and with 491,894 tons for the corresponding period of last year.

Import Duties.

The Additional Import Duties (No. 1) Order, which came into force on Monday midnight, has naturally met with a reception of a slightly mixed character, though, on the whole, so far as the leading men of industry in this area are concerned, it has been favourably received. The greatest surprise is that pig iron is not included in the list of iron and steel products to which the full duty of 33⅓ *ad valorem* is to apply. It is natural to assume that our foreign competitors will concentrate their attention on sending to this country supplies of pig iron in view of the full duty applying to semi-finished iron and steel goods. The exclusion of pig iron from the Order will detrimentally affect the coal industry as blast-furnaces are the largest consumers, and, furthermore, it will operate against the production of native iron ore. Its bearing on employment is important. Hopes are entertained that a Supplemental Order will be issued to remedy what is regarded as a grave omission. As regards the tin-plate and sheet industries of this district Mr. H. C. Bond, presiding at a conference convened by the South Wales and Monmouthshire Council of Industry and Commerce at Cardiff on Friday last, said that he now looked forward with absolute confidence to the tin-plate and sheet industries in South Wales and he was certain that manufacturers would organise to produce steel at a price which would enable them to compete with manufacturers in other parts of the world.

Steel and Tin-plate Wages.

The quarterly ascertainment which governs wages in the steel trade of West Wales was received at Swansea at the end of last week and applies from May 1st to August 6th. This shows that the average price of Siemens steel bars during the period ended March 31st was £4 12s. 5d. per ton, makers' works. As the base of the sliding scale is £5 no percentages on wages will be payable and the continuance of the *ex-gratia* bonuses to the lower-paid men will be a matter of negotiation. In the case of tin-plate operatives, the wages come under a different sliding scale agreement, based on the price of tin-plates, less the cost of tin-plate bars and tin. The ascertainment, which will also govern wages to August 6th, shows no percentage and, therefore, the men's wages will remain unchanged for the next quarter. Employers have given notice to terminate the tin-plate sliding scale agreement, and this takes effect at the end of July. When the annual trade conference of the tin-plate section of the Transport and General Workers' Union is held at Swansea on the 30th inst., unemployment in the industry is to receive special attention, and discussion will take place on the question of the shortening of the working day and the spreading out of orders.

Tin-plate Minimum Abandoned.

South Wales makers of tin-plates decided at Swansea on Tuesday to continue the pooling scheme, but to abandon the fixed minimum price of 16s. per basis box as from the following day—Wednesday. In the circumstances, the tin-plate market is nominal at 15s. to 16s. As the result of the duty on foreign steel, the quotation for foreign bars at Swansea is raised from 69s. to 83s. to 84s. per ton, delivered South Wales. Welsh bars are quiet at 95s. per ton delivered. It is reported that the likelihood is that the price will be reduced rather than increased, in order to drive foreign steel from Welsh works altogether.

Trade of South Wales.

According to the returns of the Great Western Railway Company for the six docks in this area under their control, imports and exports for the four weeks ended April came to 1,822,587 tons, as compared with 2,078,868 tons for the corresponding period of last year. For the whole of this year to April imports and exports combined amounted to 7,117,247 tons, as compared with 7,256,544 tons for the same period of 1931, and with 11,254,320 tons for the same period of 1930.

Current Business.

The tone of the market remains without any improvement, and the amount of new business passing is extremely restricted. All grades of coal are freely obtainable, though dry descriptions continue to be steadier than other coals. Patent fuel has been slightly advanced in price owing to the rise in the cost of pitch. Coke moves off rather slowly, while pitwood is still weak owing to supplies being in advance of demands.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE STEDALL-DOWDING MACHINE TOOL COMPANY, 145 to 157, St. John-street, London, E.C. 1, has been appointed sole selling agent in Great Britain for the Naxos-Union Company, of Frankfort-on-Main.

MR. J. L. CHALONER informs us that he has re-established his consulting practice, and is specialising in oil engines of all kinds for land, marine, and road transport purposes. His address is 13, Rood-lane, London, E.C. 3 (telephone, Royal 8611).

THE BRITISH ELECTRIC TRANSFORMER COMPANY has recently appointed Mr. Norman Tegetmeier, M.I.E.E., 20, Windsor-place, Cardiff, to represent it in South Wales as district manager for its transformers. Mr. Tegetmeier has for some time acted in a similar capacity for the Tricity and Kye lamp departments of the company, but will now represent it in the area for the whole of its products.

MESSRS. H. M. AND F. M. SELSON inform us that they are retiring from the Selson Engineering Company, Ltd., and are starting business for the sale of machine tools and accessories under the title The Selson Machine Tool Company, Ltd., 23, Abbey House, Victoria-street, London, S.W. 1. The new company has arranged to complete the unexecuted orders of the Selson Engineering Company, Ltd.

PARIS TRADE FAIR, 1932.—The universal and international trade fair will be held in the Exhibition Park, Porte de Versailles, Paris, from Wednesday, May 4th, to Wednesday, May 18th, 1932. The London office of the Fair is at 143, Fleet-street, E.C. 4, and the Southern Railway is arranging to issue special cheap tickets for the duration of the Fair.

KELVIN MEDAL.—The Kelvin Medal is to be presented to the Marchese Guglielmo Marconi, G.C.V.O., LL.D., D.Sc., at the Institution of Civil Engineers, by Lord Rutherford on Tuesday next at 5 p.m. The Medal is awarded as a mark of distinction in engineering work and investigation of the kinds with which Lord Kelvin was especially identified. This is the fifth triennial award of the Medal, which has in previous years been given to Dr. W. C. Unwin, F.R.S. (Great Britain), Professor Elihu Thomson, D.Sc. (U.S.A.), the late the Hon. Sir Charles A. Parsons, O.M. (Great Britain), and Monsieur André Blondel (France).

TESTING WORK FOR THE BUILDING INDUSTRY.—In recent years there has been a growing demand on the Building Research Station of the Department of Scientific and Industrial Research for tests and reports on building materials and forms of construction. In order to enable the Station to cope with these requests, a panel of approved testing laboratories is being established to act in association with the Station. The essence of the scheme is to put the Station in the position to have tests carried out at laboratories on the panel, and then to incorporate the results in Government reports or certificates issued by the Station. The bulk of the tests will probably be mechanical or physical; of the chemical tests, most will probably be simple analyses. Applications are invited from testing laboratories wishing to participate in the scheme. Further particulars and forms of application can be obtained from the Director, Building Research Station, Garston, Herts.

I.E.E. GOLF MEETING.—In aid of its Benevolent Fund, the Institution of Electrical Engineers proposes to hold a golf meeting on June 30th, the day of the Institution conversazione. The Committee has arranged with Moor Park Golf Club, Rickmansworth, for the use of the Club premises. There are three courses, and it is proposed to have a medal round of thirty-six holes, one round on the High Course and one round on the West Course. A bogey competition will also be held. The third course will be available if a sufficient number of entries is secured. The entrance fee for each competition will be 10s. 6d., which will include the green fee for the day. As it is anticipated that many will desire to play and as the numbers must be limited by the capacity of the course, early application is necessary. The applications will be taken in the order of receipt. The competitions are open only to male members of all classes of the Institution, and competitors must have a Club handicap of not more than 24. The Hon. Secretary of the Competition is Mr. Percy Rosling, at the Institution offices, Savoy-place, Victoria Embankment, W.C. 2.

"ARMSTRONG WHITWORTH RECORD."—The place of honour in the latest issue of the *Armstrong Whitworth Record* is given to an article entitled "A Great Victorian," which is, in fact, a memoir of Sir Andrew Noble, who was chairman of Sir W. G. Armstrong, Whitworth and Co., Ltd., from 1901 till his death in 1915. It opens with the just observation that "the greatness of great men lies not only in their personal achievements, but also in their ability to delegate authority, and to judge the merits in others." That Sir William Armstrong possessed that quality in a marked degree is shown by the men he collected around him, and the trust he imposed in them. Amongst these men was Sir Andrew Noble, who, when no more than a young artillery officer, was selected by Armstrong to help him at possibly the most critical period of the firm's history. He was appointed at the age of twenty-nine joint manager of the Ordnance Works with George Rendel, then only twenty-seven. That was in 1860; twenty years later Noble was in full control of the whole works. No man ever served a firm more faithfully. To "Armstrong's" he devoted all his great and varied talents, and for many years he kept himself in close touch with every detail, even, of that immense firm. This very sympathetic memoir will be read with interest and pleasure by all old Elswick men with whom Noble and his ways have become a tradition.

JUNIOR INSTITUTION OF ENGINEERS.—The annual dinner of the Junior Institution of Engineers, which celebrated the forty-eighth anniversary of the foundation of the Institution, was held on Friday evening last, April 22nd, at the Whitehall Rooms of the Hotel Metropole. A large number of members and guests attended, and the evening was throughout a most enjoyable one. Mr. W. A. Tookey, performed the honorary duties of toastmaster in his time-honoured fashion, to which, however, he imparts a note of freshness each succeeding year. The chairman was Dr. Standen Leonard Pearce, M. Inst. C.E., M.I.E.E., M.I. Mech. E. The toast of "The Institution" was proposed by Sir Cyril Kirkpatrick, M. Inst. C.E., President of the Institution of Civil Engineers, who referred in fitting terms to the approaching jubilee of the "Juniors" and to the high esteem in which the Institution was held by his own and other leading institutions. Mr. J. Forster Petree, A.M.I. Mech. E., A.M.I.N.A., the Chairman of the Institution, replied. Captain Donaldson, M.I.E.E., the President of the Institution of Electrical Engineers, proposed the toast of "The Electrical Supply Industry" and said that electrical engineers had still a great task before them if they were to fulfil their part in the supply of light and heat energy for industrial purposes. Dr. Pearce responded and enumerated some of the honoured men who had filled the post of President of the Junior Institution of Engineers. The toast of "Our Guests" was given in happy terms by Mr. Horace P. Wright, the Vice-Chairman of the Institution, and Sir Alexander Gibb, who is the President-elect of the Institution, and Sir Felix J. C. Pole replied. The Vice-Chairman of the Institution, Mr. Ernest Ambrose, M.I.E.E., proposed a vote of thanks to the chairman. Between the speeches musical items were rendered, and the evening was a very successful one in all respects.

Current Prices for Metals and Fuels.

IRON ORE.

N.W Coast—	
(1) Native	16/6 to 20/–
(1) Spanish	17/– to 22/6
N.E. Coast—	
Native	18/– to 21/–
Foreign (c.i.f.)	15/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 8 6	—
No. 1 Foundry	3 12 0	—
No. 3 Foundry	3 9 6	—
N.E. Coast—		
Hematite Mixed Nos.	3 3 6	3 3 6
No. 1	3 4 0	3 4 0
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
Midlands—		
(c) Staffs.—	(*Delivered to Station*).	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	3 15 6 (a) / 4 0 6 (b) / 4 5 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	9 15 0	9 5 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 5 0	—
Common Bars	9 5 0	—
Best Bars	10 5 0	—
Double Best Bars	10 15 0	—
Treble Best Bars	11 5 0	—
Lancs.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 0 0	—
S. Yorks.—		
Crown Bars	9 15 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	9 2 6 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 7 6	—
Gas Tube Strip	10 10 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	9 0 0	8 10 0
„ „ (Land)	—	—
Ship Plates, ½in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 15 0	7 15 0
Sheets (Gal. Cor. 24 B.G.	10 15 0	10 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	7 2 6	—
Soft Billets	5 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
Manchester—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 0 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	8 12 6	—
Sheffield—		
Siemens Acid Billets	9 2 6 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	6 12 6 and 7 2 6	—
Soft Basic	6 0 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 10 0	—
Midlands—		
Small Rolled Bars (all British)	7 5 0 to 7 15 0	—
Small Re-rolled Bars	6 7 6 to 6 10 0	—
Billets and Sheet Bars	5 5 0 to 5 10 0	—
Galv. Sheets, f.o.b. L'pool	9 5 0 to 9 7 6	—
(2) Staffordshire Hoops	9 10 0	—
(d) Angles	8 7 6	—
(d) Joists	8 15 0	—
(d) Tees	9 7 6	—
(d) Bridge and Tank Plates	8 17 6	—
Boiler Plates	8 7 6 to 8 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14 f.o.b.	15/– to 16/–
Block Tin (cash)	116 5 0
„ (three months)	118 5 0
Copper (cash)	30 8 9
„ (three months)	30 12 6
Spanish Lead (cash)	11 15 0
„ „ (three months)	12 0 0
Spelter (cash)	12 11 3
„ (three months)	12 16 3
Manchester—	
Copper, Best Selected Ingots	35 0 0
„ Electrolytic	36 10 0
„ Strong Sheets	63 0 0
„ Tubes (Basis Price), lb.	0 0 9¾
Brass Tubes (Basis Price), lb.	0 0 9
„ Condenser, lb.	0 0 11¼
Lead, English	13 17 6
„ Foreign	12 2 6
Spelter	12 17 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/3½ per lb.	
Ferro Tungsten	2/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£25 12 6	7/–
„ „ 6 p.c. to 8 p.c.	£24 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£23 15 0	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£37 15 0	10/–
„ „ „ 1 p.c. carbon	£48 0 0	12 –
„ „ „ 0·70 p.c. carbon	£52 0 0	13/–
„ „ „ carbon free	1/1 per lb.	
Metallic Chromium	3/– per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£10 0 0 scale 5/– per unit	
„ „ 75 p.c.	£17 15 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	6/3 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£250 to £255	
Ferro Cobalt	10/– per lb.	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	13/– to 13/3
„ „ Ell	14/3
„ „ Splint	14/3 to 15/6
„ „ Trebles	11/6
„ „ Doubles	9/9
„ „ Singles	8/9
Ayrshire—	
(f.o.b. Ports)—Steam	12/–
„ „ Jewel	16/6
„ „ Trebles	12/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	11/– to 11/9
Screened Navigation	16/6
Trebles	11/– to 13/–
Doubles	9/9 to 10/–
Singles	8/9
Lothians—	
(f.o.b. Leith)—Best Steam	11/– to 11/6
Secondary Steam	10/9 to 11/–
Trebles	11/–
Doubles	9/9 to 10/–
Singles	8/9 to 9/–

(8) N.W. Coast— ENGLAND.

	Inland.
Steams	21/9
Household	32/6 to 51/8
Coke	20/– to 22/6
Northumberland—	
Best Steams	13/6
Second Steams	12/3 to 12/6
Steam Smalls	8/6
Unscreened	12/6 to 13/–
Household	27/– to 39/–
Durham—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–
Sheffield—	Inland.
Best Hand-picked Branch	26/6 to 27/6 —
South Yorkshire Best	22/– to 23/– —
Derbyshire Best Bright House	22/– to 23/– —
Screened House Coal	19/– to 20/6 —
Best Screened Nuts	17/– to 18/– —
Small Screened Nuts	14/6 to 15/6 —
Yorkshire Hards	16/– to 18/– —
Derbyshire Hards	16/– to 18/– —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	7/– to 8/6 —
Smalls	5/– to 6/– —

Blast-furnace Coke (Inland) 12/– to 12/6 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b., 18/– to 18/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals :	
Best Smokeless Large	19/6 to 19/9
Second Smokeless Large	18/9 to 19/6
Best Dry Large	19/– to 19/6
Ordinary Dry Large	17/9 to 18/3
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/–
Best Eastern Valley Large	17/7½ to 17/9
Ordinary Eastern Valley Large	17/3 to 17/6
Best Steam Smalls	13/– to 13/6
Ordinary Smalls	11/– to 13/–
Washed Nuts	19/– to 25/–
No. 3 Rhondda Large	19/6 to 19/9
„ „ Smalls	15/– to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/6 to 36/6
Furnace Coke (Export)	17/– to 18/–
Patent Fuel	19/– to 19/6
Pitwood (ex ship)	19/– to 20/6
Swansea—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/6
Seconds	27/– to 32/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 48/6
Nuts	40/– to 48/6
Beans	28/6 to 32/6
Peas	19/– to 21/–
Breaker Duff	8/6 to 9/6
Rubbly Culm	8/3 to 8/9
Steam Coals :	
Large	20/– to 20/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate ; Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Trade Developments.

THE tightening up of markets with the aid of import duties and quotas is necessarily affecting the future course of production, and French manufacturers do not believe that there will ever be a complete recovery from the heavy decline that has taken place in the steel output. The steel industry has been developed on too vast a scale, and however much the demand may revive when the economic crisis is at an end, there will always, it is feared, be an inconvenient surplus supply, unless something is done to keep it within reasonable limits. This systematic restriction is being accomplished in France, where the organisation of steel production and sales is giving some tangible result. Efforts are being made to promote the consumption of steel at home and in the Colonies, for which purpose the Office pour l'Utilisation de l'Acier has sent a delegate to Morocco to lecture on the advantage of steel over other structural materials. At the same time, the present situation must in time give way to a rational organisation of foreign trade. The Minister of Commerce has affirmed that the French Government is anxious to assist in attaining that end, while it is satisfactory to learn that, as the result of protests from Great Britain and the United States against the methods of distributing quotas, the Minister of Commerce has promised to adapt them in such a way as to ensure fair treatment all round. The increased import duties on semi-manufactured steel into Great Britain have shown foreign countries the hopelessness of replying to restrictions by discriminating measures. The fact, moreover, that all these measures are regarded as temporary, with a view to national protection under abnormal economic conditions, in order to allow of a general trade reorganisation, leaves an impression that anything in the way of reprisals is out of place. The French see that, for the moment, they must work to save the home and colonial markets, and prepare to develop foreign trade when opportunity arises. This implies the bringing of production costs into line with those of competing countries, but the fiscal charges on industry and the high cost of living make it very difficult to effect economies or reduce wages. In Belgium there can be no relief except by wage reductions. In the Grand Duchy of Luxemburg wages in the steel industry have been cut by another 7½ per cent., following upon a continued weakness of steel quotations in Brussels. As all efforts to secure unanimity amongst Belgian steel producers with a view to the reconstitution of the Steel Cartel have failed, the future of that organisation is not regarded with much hopefulness.

Local Railways.

The railway companies are no longer obliged by their convention with the State to run a minimum of three trains a day each way on rural local lines where there is a small and irregular traffic, but they must still keep stations open in charge of men who are on service eight hours a day, with nothing to do, while at level crossings servants must be in attendance to open and close the barriers six times in twenty-four hours. All this means considerable expense, which the companies have, so far, vainly attempted to avoid, but there appears every probability of progress being made gradually, as the result of the permission which has been accorded to them to close stations temporarily and to run motor vehicles experimentally on the rail and road. The Midi Company has been carrying out extensive trials with an oil rail motor, with carrying capacity for sixty passengers and running up to 55 miles an hour, and eleven such vehicles have been ordered to be put into service this year on 225 miles of line around Mont-de-Marsan. The P.L.M. Company has also been authorised to run experimentally rail motors, which gave satisfactory results in trials last year, and the company has selected eight different types from builders who submitted them in competition, and twenty-two have been ordered to be put into service this year. On the Est Railway pneumatic-tired rail omnibuses have been tried, and it appears that the next year or two will see the employment of a number of such vehicles. With the closing of rural stations and the installation of automatic signalling at level crossings, the railway companies will be able to effect considerable economies.

Glass Houses.

A building is being erected in the rue Chevaleret, in Paris, which is noteworthy in having three sides completely glazed with about a thousand square metres of double sheets of glass, between which warm air will be circulated in winter and cold air in summer, so that the temperature inside will remain constant all through the year. There are no windows that can open, and, except for the doors, the building will be hermetically closed. Filtered air at the required temperature will be circulated inside. The double glazed walls will exclude all outside noise. On account of the glazed construction, the building is supported on a large number of reinforced concrete piles extending from the foundation to the top. The glass construction with air circulation has been subjected to extensive experiments at the St. Gobain glassworks.

Anthracite Coal.

A fairly large proportion of the coal mined in France is anthracitic and friable, and most of it was of small commercial value until methods were introduced of preparing a composite fuel, which was sold for purposes for which anthracite is used. The results do not appear to have been successful, and at a recent meeting of the Société de l'Industrie Minérale, Monsieur Charles Berthelot said that there was no alternative but to encourage the employment of this small anthracitic coal with special heating apparatus or to carbonise the fuel. Monsieur Berthelot believes that carbonisation offers the real solution of the coal problem in the Colonies, where the production of anthracite is about 2,000,000 tons a year. It is possible, he said, to carbonise anthracite in Tonkin and employ the coke for the production of pig iron in the Haipong district. In this way Tonkin could produce 600,000 tons of pig iron a year, which would find a market in Japan in competition with China and India.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

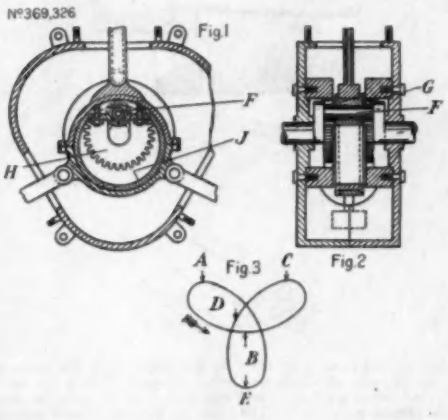
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

369,326. January 30th, 1931.—MECHANICALLY GEARED INTERNAL COMBUSTION ENGINES, A. Roger, Fairfield Cottage, Great Budworth, near Northwich, Cheshire.

This is a three-cylinder radial engine, the three connecting rods being shown, but not the cylinders. On the crank pin F there are two pinions G, which mesh with an internally toothed, fixed wheel H. The crank pin also passes through an excentric sheave J to the strap of which the connecting-rods are attached. For any one cylinder if the point marked A in Fig. 3 represents the commencement of induction, then the induction may possibly end at about the point marked B, so that the distance anti-clockwise along the curve from A to B will then be the induction curve, and the vertical distance between the points A and B will represent the stroke of the piston for the induction period. For the period of compression, the distance between the point B and a new point C may be said to be the compression curve. Assuming the portion of the stroke for compression to

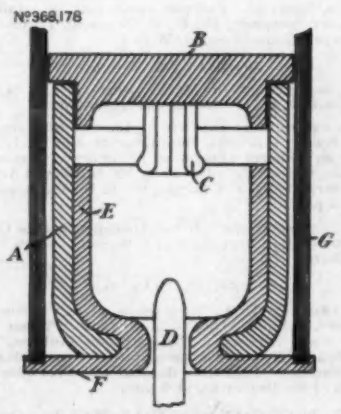


equal that for induction, then the point C may indicate the ignition point, so that the expansion curve may practically extend from point C through the mid-point D down to the bottom point marked E, and the vertical distance between the points C and E represents the expansion stroke. It will be seen to be considerably longer than the vertical distance for the induction period named. In other words, between points A and C the centre of the end of the connecting-rod is swinging along a curve having a horizontal component, whereas between the points C and E the tendency of the curve involved is almost wholly vertical. In this way the portion of the stroke of the piston in the cylinder during induction is considerably less than the expansion period, if arranged as assumed in the drawings. From point E along the curve in Fig. 3 to the initial point A may be the exhaust curve. It will be seen that the main crank shaft makes one revolution for the operations involved in Fig. 3.—*March 24th*, 1932.

SWITCHGEAR.

368,178. July 3rd, 1931.—EXPLOSION POTS FOR ELECTRIC OIL SWITCHES, International General Electric Company, Incorporated, of 120, Broadway, New York.

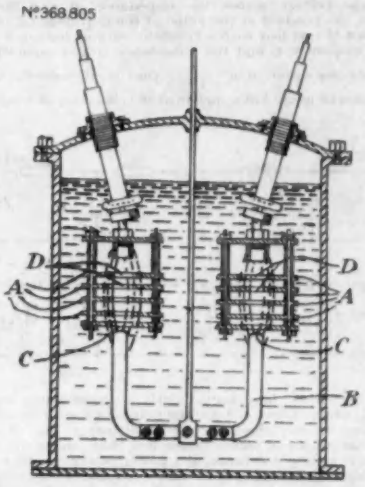
An explosion pot for oil switches constructed in accordance with this invention comprises a metal carrier A forming the body of the pot which is closed at its outer end and supported by the cover B carried by the stationary socket contact C. The movable plugging contact is shown at D. The greater part of the internal surface of the carrier A which is exposed to the effects of the arc is coated with an insulating material E moulded thereupon, this coating being extended around the aperture in



the carrier through which the movable contact D is adapted to pass to form a disc-like portion F formed integrally therewith. It is, of course, desirable to extend insulation over the outside of the carrier, as there is a tendency for the arc to be transferred from the contact C to the carrier A as the movable contact D passes out of the aperture, assuming there to be no insulating covering on the carrier A. The disc-like portion F preferably serves as shown as a support for the insulating cylinder G which surrounds the external surface of the carrier A. In this way the carrier A is substantially completely encased in insulating material.—*March 3rd*, 1932.

368,805. December 3rd, 1930.—ELECTRIC CIRCUIT INTERRUPTERS, Westinghouse Electric and Manufacturing Company, of East Pittsburg, Pennsylvania.

An oil switch constructed in accordance with this invention has a number of washers or plates A arranged in the arc path. The washers are constructed of fibrous material, such as Fuller board, which absorbs the quenching fluid and retains it in its pores, where it is available in the vicinity of the arc after the gas bubble C that forms has expanded beyond the opening D in the washers. The liquid about the arc, when the circuit is opened, is continuously decomposed by the heat of the arc, and the gases so generated move turbulently into the arc path, and, mixing with highly ionised portions which are carrying

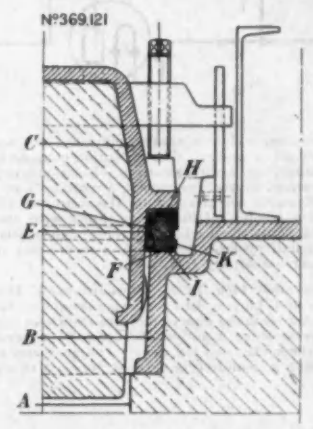


current, will withdraw ions, as a result of the diffusion from the highly ionised parts into the un-ionised colder parts of the gas which has just been introduced into the space. The holes in the washers aligned with the arc supply liquid in its immediate vicinity even though the bubble has been expanded beyond the washers. The liquid retained by the washers is decomposed by the arc, and fresh gases are continually given off and pass turbulently through the highly ionised current carrying portions of the bubble.—*December 3rd*, 1932.

GAS PRODUCERS.

369,121. July 24th, 1931.—SEALING THE DOORS OF COKE OVENS, H. J. Limberg, 3, Olgastrasse, Essen-Ruhr, Germany.

This invention relates to the doors of coking and gas generating ovens, of the kind in which a rope of asbestos is used as a packing for making a gas-tight joint at the rim. The asbestos packing is partly enclosed by a sheath of thin sheet metal, whereby it is faced at the part abutting against the door frame, and a flange of which extends between the body of the door and the inside of the asbestos rope, but leaves a portion of this inside surface bare so that it abuts directly against the door. In the drawing A designates the door aperture and H the door frame, C being the door, which is of the plug type. The door has a flange, to which is fixed an iron frame H of L-section. This frame H may be adjustable relatively to the rigid door body, to allow



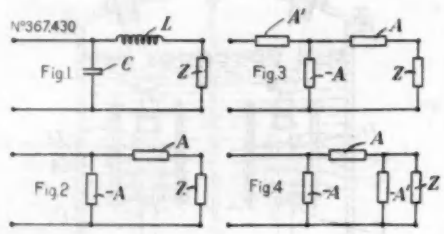
of correcting distortion. Between this iron frame H and the door body C there is an asbestos rope G which is pressed towards a seating surface F on the door frame B, but does not make direct contact therewith, being faced with a sheath I of thin steel sheet metal having on the outer side a flange K, and on the inside a larger flange E. This flange E lies between the asbestos rope G and the door C, but leaves a portion of the inside exposed. The sheath constitutes a holder for the rope and the transverse stresses set up in the asbestos rope G, due to the shutting of the door, cause the flange E to be pressed tightly against the door, as is also the exposed portion of the inner rope surface. This prevents the creeping of gas. The flexibility of the asbestos rope G and the flexible metal sheath I is generally sufficient to maintain a tight joint, without requiring artificial adjustment, notwithstanding the distortion to which the door is subject in use.—*March 17th*, 1932.

MISCELLANEOUS.

367,430. November 20th, 1930.—MEANS FOR OBTAINING CONSTANT VOLTAGE IN ALTERNATING-CURRENT CIRCUITS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2; and Norman Richard Bligh, of Research Laboratories of the General Electric Company, Ltd., Wembley, Middlesex.

Several means are known for keeping the current through a circuit constant when the voltage of the supply varies. The object of this invention is to maintain the voltage constant across an element, such as a valve filament, of which the impedance varies. According to the invention electrical apparatus for supplying a variable impedance element with current from an A.C. variable voltage source in such a manner that the voltage across the element remains constant comprises a Boucherot circuit with the element arranged in place of the impedance of the circuit and means for automatically supplying the circuit with constant current of characteristic frequency from the variable voltage source. The element may

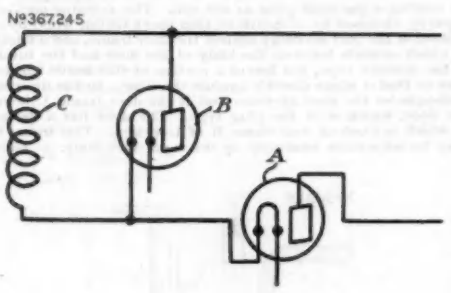
be the filament of a valve or lamp or the primary winding of a transformer. In the latter case the transformer may supply current to the filament of a valve or lamp. The means for supplying constant current may be a barretter or a constant current transformer. By a Boucherot circuit is meant any of the circuits devised by Boucherot, in which the voltage across an impedance in the circuit is independent of the value of that impedance so long as the circuit is supplied with constant current of a definite frequency, *i.e.*, the characteristic frequency of the circuit. One such circuit is shown in Fig. 1. In this circuit the voltage across the impedance of the Boucherot circuit is independent of the value of the impedance Z provided the circuit is supplied with a constant current having a characteristic frequency ω and the inductance L and capacity C are related by the equation $\omega^2 = \frac{1}{L\,C}$; that is, the reactances of L and C must be equal but opposite at the characteristic frequency.



The above circuit may conveniently be represented as shown in Fig. 2, where A and $-A$ are the values of the series and shunt reactances at the characteristic frequency. The Boucherot circuit has an input power factor less than unity. If the impedance is a pure resistance, the power factor can be raised to unity either by inserting a reactance of value A—at the characteristic frequency—in series with the circuit, as shown at A^1 in Fig. 3, or by inserting a reactance of value A in parallel with the impedance, as shown at $-A^1$ in Fig. 4. The circuits of Fig. 3 or Fig. 4 act as pure resistances at the characteristic frequency. Where a transformer winding is inserted as impedance Z, the leakage reactance of the transformer may replace or be included in the reactance A. Thus the voltage across the winding is maintained constant in spite of variations due to the leakage reactance, and regulation of the transformer on load is thereby avoided.—*February 22nd*, 1932.

367,245. May 4th, 1931.—THE SUPPLY OF A DIRECT-CURRENT ELECTRO-MAGNET FROM AN ALTERNATING-CURRENT SOURCE, *Igranic Electric Company, Ltd., of* 147, *Queen Victoria-street, London, E.C.* 4.

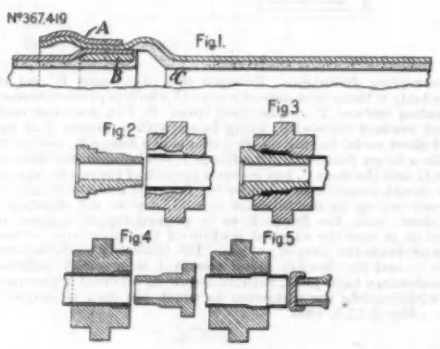
This invention relates to a method and apparatus for supplying a direct-current electro-magnet from an alternating-current source. An object of the invention is to provide an arrangement which requires a minimum of apparatus. Another object is to



provide apparatus, which is simple, efficient, and consumes a minimum amount of energy. The invention consists broadly of means for supplying a direct-current electro-magnet from an alternating-current source, comprising a rectifier A to pass only alternate half waves of current from the source to the electro-magnet, and a second rectifier B in shunt with the electro-magnet, to pass only the discharge current of the electro-magnet C during the half cycles when the first-mentioned rectifier is non-conducting.—*February 18th*, 1932.

367,419. November 14th, 1930.—PIPE JOINTS, F. Herbert and Stewarts and Lloyds, Ltd., 41, Oswald-street, Glasgow.

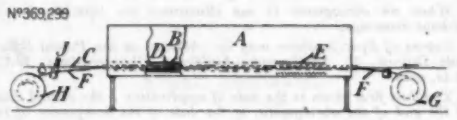
In this joint a seamless pipe of uniform thickness is reinforced at one end by a sleeve A and at the other by a ferrule B—see Fig. 1. For the socket end the sleeve is slipped over the pipe—see Fig. 2—and a mandrel is pushed forward to expand the



pipe. At the end of the stroke the material of the pipe is buckled up into the beads of the mould—see Fig. 3. For the spigot end the pipe is first enlarged—see Fig. 4—and the ferrule is then driven in—Fig. 5. It is claimed that this construction enables the interior of the pipe to be completely protected by bitumen, as shown at C, Fig. 1.—*February 15th*, 1932.

369,299. December 24th, 1930.—CONTINUOUS HEAT-TREATMENT OF SIGNALLING CONDUCTORS, Willoughby Statham Smith, of Benchams, Newton Poppleford, Devonshire, and Cuthbert Victor Henry Garnett, of Woodhall, Woodhall-rise, Sevenoaks, Kent.

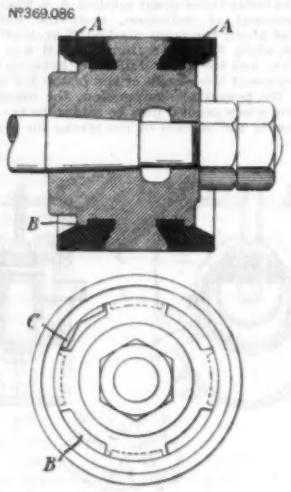
The apparatus described in this specification is particularly applicable to continuously loaded submarine signalling conductors subject to heat treatment for the purpose of developing the magnetic properties of the layers of loaded material. A indicates the furnace and B the heating tube through which the conductor C passes. D is a water jacket, and E heating resistances. In its passage through the tube B the conductor is carried by a copper tube F supplied from the drum G, and is fed on to the drum H. On its separation from the conductor at the exit end of the furnace, the tape C may be passed through flattening rolls J in order to facilitate the winding operation. Means are also provided for making the linear speed of the



tape and wire identical. The invention is claimed to prevent mechanical damage to the conductor and to offer other advantages over existing methods of heat-treatment.—*March 24th*, 1932.

369,086. June 6th, 1931.—PISTON PACKING RINGS, Wilson-Snyder Manufacturing Corporation, 100, Talbot-avenue, Braddock, Pennsylvania.

The rings A, A of this pump bucket are made of rubber, or some such material, and are cupped, so that they tend to



make a tight joint with the cylinder walls under the influence of the pressure of the liquid being pumped. The rings are of dovetail form, as shown, and are held in place by a bayonet-joint arrangement B, B. The rings are prevented from working round and becoming loose by a detent C, which is moulded on the ring and is forced into place.—*March 17th*, 1932.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF ELECTRICAL ENGINEERS: METER AND INSTRUMENT SECTION.—Savoy-place, Victoria Embankment, London, W.C. 2. "Future Progress in Electrical Measuring Instruments," by Dr. C. V. Drysdale. 7 p.m.

KEIGHLEY ASSOCIATION OF ENGINEERS.—At the Queen's Hotel, Keighley. Annual general meeting. 8 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Rival Theories of Hearing," by Mr. H. Hartridge. 9 p.m.

SATURDAY AND SUNDAY, APRIL 30TH AND MAY 1ST

ENGINEERING GOLFING SOCIETY.—Spring meeting at Burnham-on-Sea, Somerset. Full particulars may be obtained from the Honorary Secretary, Mr. G. H. Hopewell, Foster Wheeler, Ltd., Aldwych House, London, W.C. 2.

MONDAY, MAY 2ND.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Annual meeting. 5 p.m.

SOCIETY OF CHEMICAL INDUSTRY: LONDON SECTION.—In the Chemical Society's Rooms, Burlington House, W. 1. General discussion on "Smoke Abatement in Industry," opened by Mr. E. C. Evans, who will be followed by Mr. H. Clifford Armstrong, Mr. R. J. Sarjant, Dr. J. S. Owens, Dr. E. W. Smith, and Dr. R. Lessing. 8 p.m.

SOCIETY OF ENGINEERS.—In the Apartments of the Geological Society, Burlington House, W. "Rocket Theory," by Dr. Herbert Chatley. 6 p.m.

TUESDAY, MAY 3RD.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Thirty-eighth James Forrest Lecture, entitled "Some Aspects of the Corrosion Problem," by Mr. Ulick R. Evans. 6 p.m. The presentation of the Kelvin Medal, 1932, to Marchese Guglielmo Marconi will take place in the Great Hall of the Institution at 5 p.m.

TUESDAY, THURSDAY, & FRIDAY, MAY 3RD, 5TH, & 6TH.

UNIVERSITY OF LONDON.—In the Department of Applied Statistics, University College, Gower-street, W.C. 1. Advanced Lectures in Statistics. Three lectures, "The *Rôle* of Statistical Method in Industrial Standardisation," by Dr. W. A. Shewhart. 5.30 p.m. each day. Admission free.

WEDNESDAY, MAY 4TH.

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY.—At the London School of Economics and Political Science, Aldwych, W.C. 2. "Psychological and Social Factors in Business Rationalisation: The Significance of Rationalisation," by Dr. Charles S. Myers. 5.30 p.m.

WEDNESDAY TO WEDNESDAY, MAY 4TH TO 18TH.

PARIS TRADE FAIR.—Exhibition Park, Porte de Versailles. Open daily. London office of the Fair, 143, Fleet-street, E.C. 4.

THURSDAY, MAY 5TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. Varley Centenary Commemoration Meeting. A short discourse on "The Lives and Work of Cromwell Fleetwood Varley (April 6th, 1828) and Samuel Alfred Varley (March 22nd, 1832)," by Lieut.-Col. A. G. Lee. 6 p.m. Annual general meeting, 6.45 p.m.

ROYAL AERONAUTICAL SOCIETY.—In the Royal Society of Arts, 18, John-street, Adelphi, W.C. 2. "The Training of Pilots and Instructors," by Group Captain J. E. A. Baldwin. 6.30 p.m.

THURSDAY AND FRIDAY, MAY 5TH AND 6TH.

IRON AND STEEL INSTITUTE.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Annual meetings. For programme see page 377.

FRIDAY TO MONDAY, MAY 6TH TO 9TH.

INSTITUTION OF MECHANICAL ENGINEERS.—London spring meeting. For programme see page 454.

FRIDAY, MAY 6TH.

RAILWAY CLUB.—57, Fetter-lane, E.C. 4. "The Great Northern Railway of Ireland," by Mr. C. R. G. Stuart. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Conversazione. 8.30 p.m.

SATURDAY, MAY 7TH.

INSTITUTION OF ELECTRICAL ENGINEERS: METER AND INSTRUMENT SECTION.—Visit to Rugby. For details see page 379.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Visit to Heston Civil Airport. Assemble Charing Cross Embankment (Underground Station), 2 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District meeting at Gillingham, Kent. Assemble Council Chamber, Gardiner-street, Gillingham, 11.30 a.m.

MONDAY, MAY 9TH.

INSTITUTION OF SANITARY ENGINEERS.—At Caxton Hall, Westminster, S.W. 1. "Some Aspects of Central Heating Systems," by Mr. W. E. Fretwell. 7 p.m.

TUESDAY, MAY 10TH.

(NEW) INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS: BRITISH BRANCH.—In the Meeting Hall of the Institution of Mechanical Engineers, Storey's-gate, St. James's Park, London, S.W. 1. General meeting. The chair will be taken by Sir Henry Fowler, K.B.E., Chairman of the British Committee. Dr. W. Rosenhain, F.R.S., President of the International Association, will give an address on the work and objects of the Association. 7.30 p.m.

WEDNESDAY, MAY 11TH.

INSTITUTE OF FUEL.—Burlington House, Piccadilly, W. 1. "The Artificial Formation of Bituminous Coal and Mineral Oil Hydro-carbons," by Dr. Ernst Berl. Eight other technical societies have been invited to join this meeting. 6 p.m.

INSTITUTE OF METALS.—In the Hall of the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Annual May Lecture, "The Plastic Deformation of Metals," by Professor F. Körber. 8 p.m.

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY.—At the London School of Economics and Political Science, Aldwych, W.C.2. "Psychological and Social Factors in Business Rationalisation: The Dangers of Rationalisation," by Dr. Charles S. Myers. 5.30 p.m.

FRIDAY, MAY 13TH.

BRITISH ASSOCIATION OF CHEMISTS: LONDON SECTION.—The annual general meeting at the Broad-street Station Restaurant, London, E.C. 7 p.m. This meeting is taking the place of that announced for May 6th, 1932.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—At the Cowdray Hall, Aberdeen. Faraday Lecture, "Everyday Uses of Electricity," by Professor J. K. Catterton-Smith. 7.30 p.m.

SATURDAY, MAY 14TH.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Excursion from Aberdeen to Braemar. Leave Caledonian Hotel, Aberdeen, 9.30 a.m.

WEDNESDAY, MAY 18TH.

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY.—At the London School of Economics and Political Science, Aldwych, W.C.2. "Psychological and Social Factors in Business Rationalisation: The Advantages of Rationalisation," by Dr. Charles S. Myers. 5.30 p.m.

WEDNESDAY, MAY 25TH.

BRITISH SCIENCE GUILD.—At the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Polar Lights," by Professor Sydney Chapman, F.R.S. 4.30 p.m.

THURSDAY, MAY 26TH.

ROYAL AERONAUTICAL SOCIETY.—In the Science Museum, Aeronautical Section, South Kensington, S.W. 7. Twentieth Wilbur Wright Memorial Lecture. "New Methods of Research in Aeronautics," by Mr. H. E. Wimperis. Annual Council dinner. Reception and conversazione.

FRIDAY, MAY 27TH.

INSTITUTE OF TRANSPORT.—Joint meeting with the Town Planning Institute and the National Housing and Town Planning Council. "Planning and Transport," by Mr. G. L. Pepler. 6 p.m.

SATURDAY, MAY 28TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Meeting at Whitby. Royal Hotel, Whitby. 1 p.m.

MONDAY, MAY 30TH, TO FRIDAY, JUNE 3RD.

INSTITUTION OF ELECTRICAL ENGINEERS.—Summer meeting at the North Midland Centre. For provisional programme see page 379.

SUNDAY TO SUNDAY, JUNE 26TH TO JULY 10TH.

WORLD POWER CONFERENCE.—Sectional meeting in Scandinavia. For provisional programme see page 405.

TUESDAY, JULY 5TH, TO SATURDAY, JULY 9TH.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—Royal Show at Southampton.

MR. W. KERFOOT.—We learn with regret of the sudden death of Mr. W. Kerfoot, secretary of British Insulated Cables, Ltd., who was taken ill on Sunday, April 24th, at the West Lancashire Golf Club and died in the Club-house. Mr. Kerfoot, who was in his sixtieth year, joined the staff of the company, then known as the British Insulated Wire Company, in 1896. He became assistant secretary in June, 1901, and in September of the same year was appointed secretary.